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Engineering News-Record

March 7, 1935

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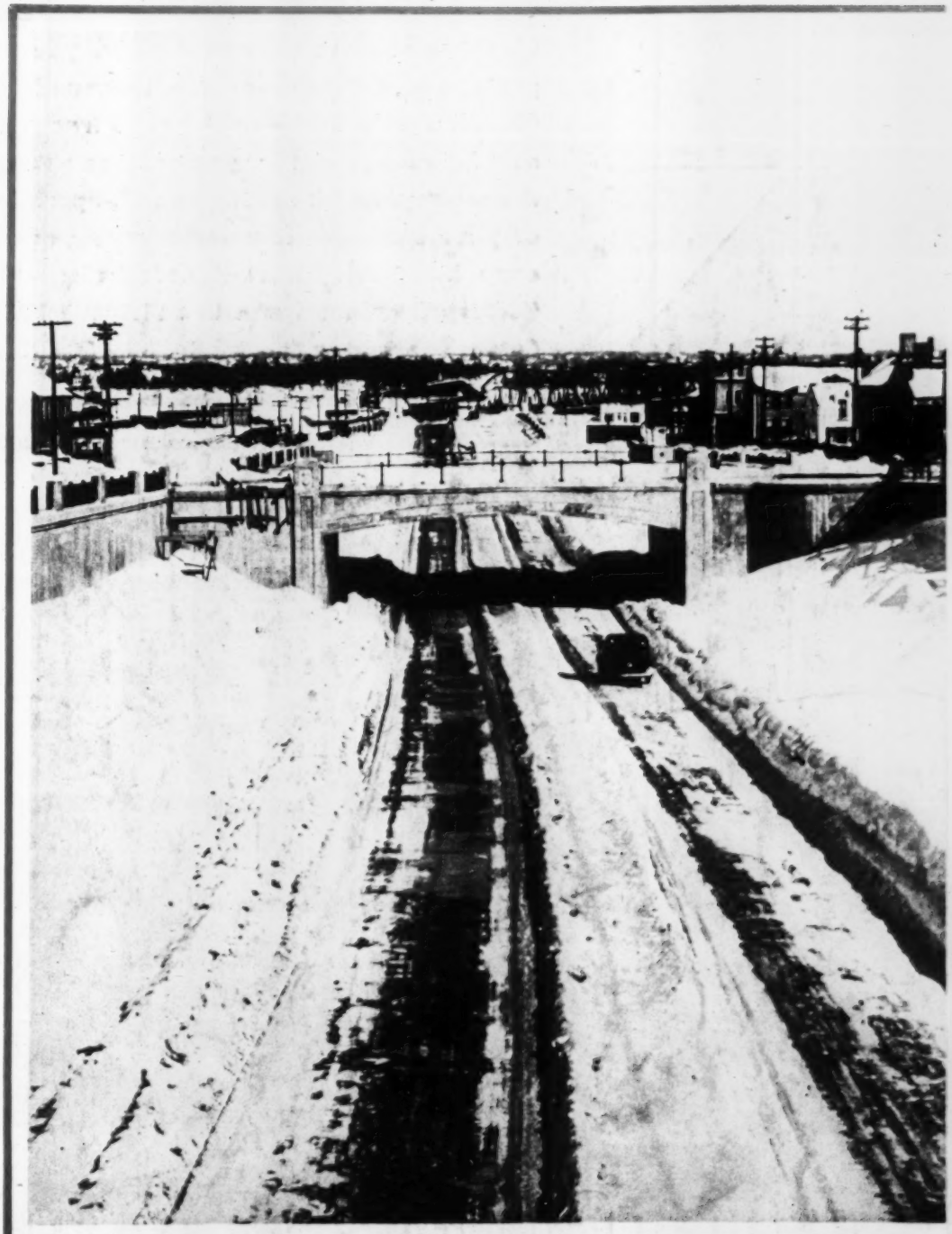

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Opened to traffic last month just in time to catch one of the year's heaviest snowfalls, the Newburyport Cutoff in Massachusetts, a two-strip highway with all street crossings separated, had to be re-opened with snowplows and trucks

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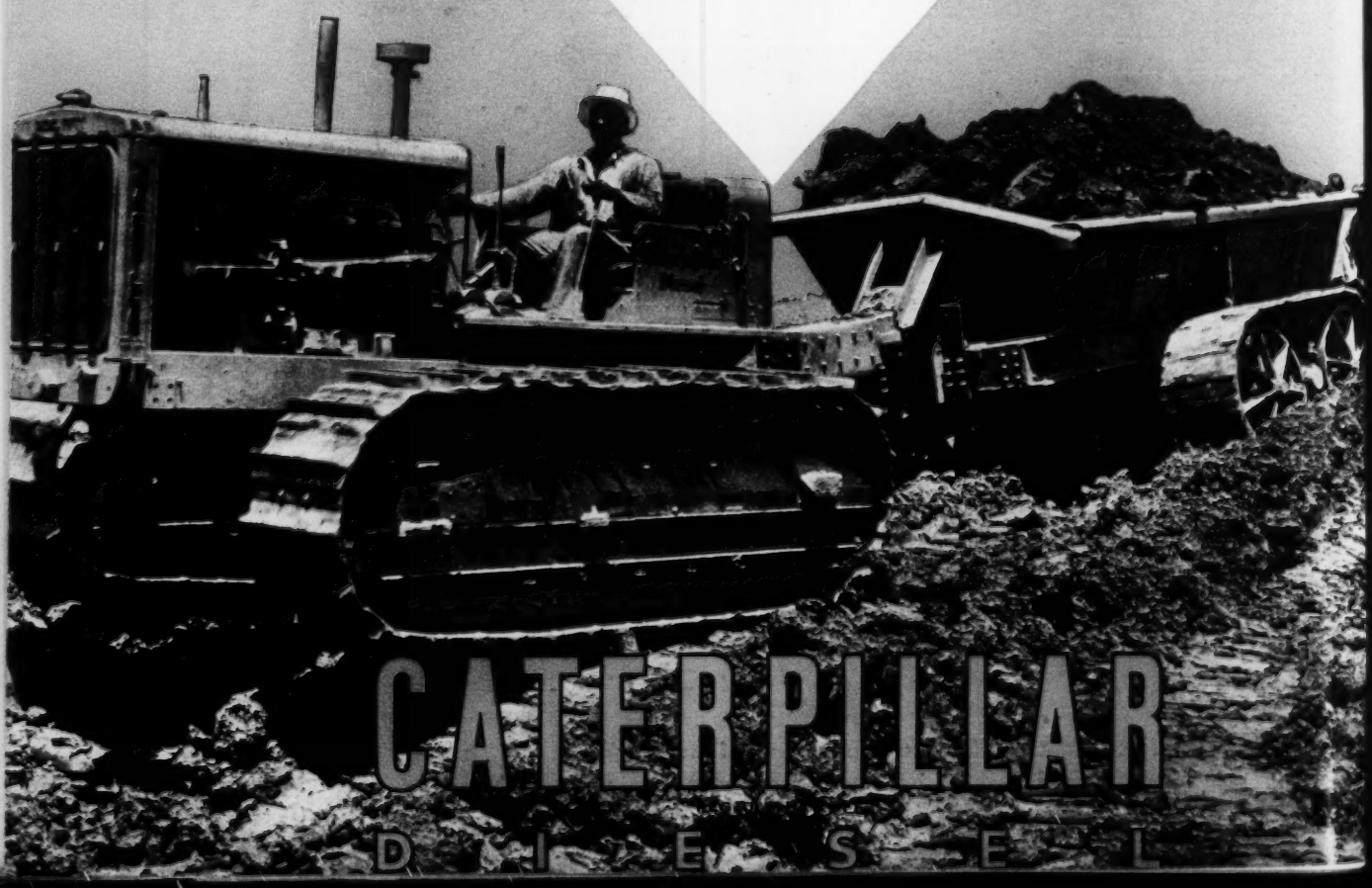

When Politics Ride Roughshod

THE present plight of the President's emergency construction program is an excellent illustration of how politics can make a mess of a constructive effort without respect to its merits. On the face of it, the program is held up because the American Federation of Labor tried to establish an amazing requirement that "prevailing wages" be paid to those now out of work, who, whether or not especially qualified, might be given jobs on emergency projects undertaken only to make employment.

The fact is that the program has been blocked by a relatively small number of Senators fighting for an exactly opposite policy. A combination of the A. F. of L. and those who are opposed to any federal unemployment relief except charity now obstructs the progress of a measure that contemplates neither destructive extravagance on the one hand nor destructive parsimony on the other.

It is true that much of the blame for this incongruous alliance must rest with those who prepared and presented the President's program. This page already has indicated some of the obscurities that interfere with clear-cut appraisal of its merits.

OF ALL the public construction that might be undertaken under such a program, it is clear that some part of it must consist of public works, normally carried on by the various divisions of government—federal, state and local. The improvement of highways, rivers and harbors, the erection of public buildings and other structures, the development of reclamation and drainage projects, the installation of waterworks and sewerage facilities and many other forms of public works must compose such a program.

On such projects it is essential that normal procedure prevail. This would mean the preparation of plans and specifications by the organized engineering and architectural profession, the award of contracts by competitive bids to qualified contractors, the normal use of materials and equipment to insure to the taxpayer the largest possible returns for his expenditure. Thus only can a public works program contribute toward a revival of private industry as well as make employment in the field for qualified workers. On such work there is no reason why the standard economic wages of labor should not prevail.

But when we turn to the "work relief" contemplated in the President's program we find wholly different conditions. In the first place, such work will consist in large measure of projects, undertaken primarily, if not exclusively, to provide employment for workers who otherwise would be dependent on charity. Such work would be, in effect, an extra effort by the community in behalf of its less fortunate members, enabling them to support themselves in some measure rather than to live on downright charity. Then, too, most beneficiaries of such employment, coming from every department of business, trade and industry, would not be especially qualified for the work available and, despite the best of intentions, could not return proportionate value for standard wages. Moreover, the payment to such workers of the same wages that are earned in competitive employment by well qualified workers naturally would tend to kill any incentive to seek work in private employment.

IF WE are to avoid the extremes represented by those who would abandon an employment policy in favor of public charity and those who would exact for all emergency workers the high scale of union wages—for that is what labor leaders mean by "prevailing wages"—it will be necessary to segregate the normal public works projects from the emergency projects in order that each may be prosecuted on a basis that will best serve the general interest and the declared objectives of the President.

What we seek is a public employment program that will prevent avoidable distress, provide an honest living for the largest possible number of employables, stimulate a revival of private industry and keep the cost of all within the limits prescribed by the requirements of the national credit. We do not want either to fasten upon the American people a permanent system of public charity, which would be the inevitable result of the dole policy, or to nationalize the construction industry in order that it may absorb, at artificially high wages, all those who at any time may prefer a government job to the more exacting productive requirements of private employment.

Willard Chevalier

ENGINEERING NEWS-RECORD

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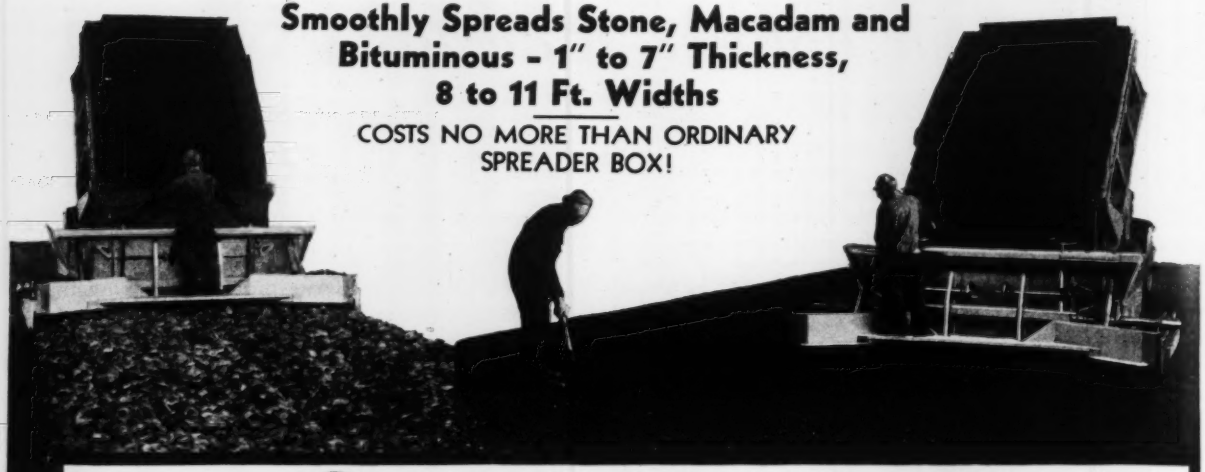

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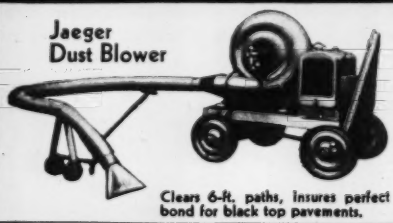

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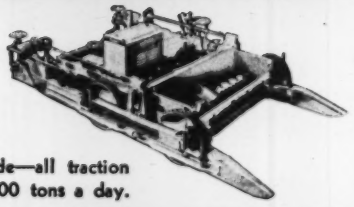

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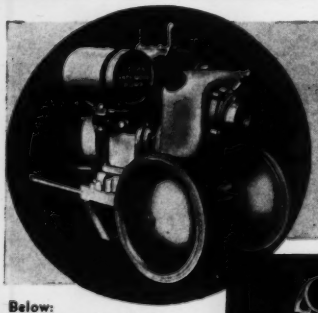

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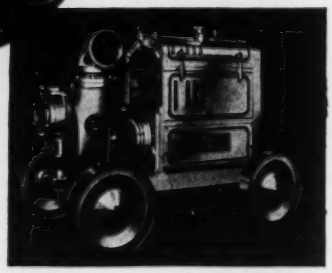

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In the News:

PRELIMINARY APPROVAL has been given by the FHA for a $1,130,000 low-cost housing project near Washington, D. C. A private loan is being negotiated to finance the work.

EXTREME drought conditions continued throughout the winter, with a deficiency of 50 per cent of normal, over a belt extending through North Dakota to Texas. Without copious spring rains, conditions in this area during the coming summer will be more severe than last year.

A PUBLIC HEARING to clarify the code of the crushed stone, sand and gravel and slag industries has been announced by NRA for March 21.

WASHINGTON DISPATCHES prophesy early action on the $4,880,000,000 work-relief legislation. The Senate Appropriations Committee on Tuesday sent the bill back to the Senate minus the prevailing wage amendment but with another amendment definitely earmarking the bulk of the money for a half dozen major types of work.

POSSIBLE PUBLIC-WORKS PROJECTS, as revealed by the national inventory which has been conducted by the PWA, now total nearly 100,000, with an estimated cost of $14,000,000,000. Three states—New York, New Jersey and Michigan—each reported more than $1,000,000,000 of work.

WITH THE TAKING OVER of the work on the 13.7-mile San Jacinto tunnel on the Colorado River Aqueduct, the Metropolitan Water District has appointed a consulting board to report on the problems in connection with this difficult unit in the aqueduct tunneling program.

A SURVEY of needed school-building construction, carried out by the Office of Education, Department of the Interior, shows that $625,000,000 can be used immediately.

In This Issue:

OBSERVATIONS on the seepage and pumping in seven large cofferdams built for lock construction on the upper Mississippi River canalization result in some valuable data and conclusions on this important type of work.

FLUME CONSTRUCTION, using timber sides, bolted to a concrete floor, was used on recent reconstruction operations on the High Line Canal in the Platte River Canyon near Denver.

THE ECONOMICS of simplification and duplication in steel-bridge design are discussed for both truss and girder types of structures. Not only the saving in initial cost but also the possibility of reducing the maintenance cost are factors of design.

CLEANING TUBERCLES from 2,000 ft. of 48-in. submerged water-intake line for an industrial plant on the shore of Lake Erie presented unusual problems, including vertical bends at both ends of the line, and resulted in the development of new equipment and technique.

LOSSES resulting from cuts and bats in laying brick paving, which have been subjects of disagreement among engineers, contractors and manufacturers, have been analyzed and reduced to a curve showing the loss of brick per square yard of pavement resulting from cutting brick for closure.

TO FOLLOW UP the review of the entire San Gabriel River flood-control development which appeared in the issue of Jan. 24, p. 113, the present article describes the rockfill Dam No. 2 in this program as to design, construction, the 12-ft. settlement after a torrential rain and the subsequent repair work, which includes the use of a temporary timber facing.

COST AND EXPERIENCE DATA on jacking 60-in. concrete pipe under two railroad fills at Rutland, Vt., comprise useful information for future planning and estimating.

FROM 75 TO 90 PER CENT of all road surfaces is made up of mineral aggregates. What is known of this important engineering material? The new thinking and increased investigation being devoted to the study of aggregates for bituminous and concrete road surfaces are outlined by F. H. Jackson, senior engineer of tests, Bureau of Public Roads.

This Week's Cover

ONE OF THE MOST REMARKABLE highway relocations of 1934 occurred in Newburyport, Mass., where the terminus of the venerable Newburyport Turnpike was changed from a circuitous route through narrow crowded streets to a modern express highway in a 200-ft. right-of-way of its own. Wholesale demolition of old dwellings was required in a 1,000-ft. section of the 6,600-ft. total length. One end of this section, transformed into a grade-separated highway, is pictured on our cover this week. An article describing the complete project will be published in the near future.

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ENGINEERING NEWS-RECORD

March 7, 1935

FIG. 1—STEEL-PILE COFFERDAM with elliptical cells filled with sand and founded on sand bottom for Mississippi lock No. 11.

Seepage and Pumping in Mississippi River Cofferdams

Conclusions based on experience with seven cofferdams enclosing about eight acres each for lock construction on the upper Mississippi River slackwater navigation improvement project

By H. G. McCormick

Senior Engineer, U. S. Engineer Office, Rock Island District, Rock Island, Ill.

THE PROSECUTION of the canalization project on the upper Mississippi River by the construction of a series of locks and dams has presented an unusual opportunity for observing a number of different types of cofferdams in use and their action under different geological conditions. During 1934 seven locks and one dam were under active construction in the Rock Island Engineer District, which extends from the mouth of the Wisconsin River to Clarksville, Mo., a distance of 366 miles. The locks in all cases lie along a shore line, and each is being constructed in one cofferdam. The dams are constructed in sections requiring the use of two or more cofferdams to cross the river.

The ancient channel of the Mississippi above Rock Island was from 1 to 2 miles wide between the bluffs and has been filled with sand and gravel to a depth of generally more than 100 ft. The present stream is very small compared to that of ancient times, and the former channel is now filled with islands and sloughs, the main channel meandering between the bluffs. At Rock Island and below, the valley is partly alluvial; the present channel is not so old, and rock occurs at several points in the bed of the stream.

Type and size of dams

The specifications for the construction of locks and dams contain certain requirements as to the stability and height of cofferdams, but the type and material to be used are left to the judgment of the contractor. Of the eight jobs under construction in the Rock Island District, the contractors elected to use lumber for cofferdams at four of the sites, and steel sheetpiling at the other four. The four dams built of lumber were all of the type known as the Ohio River Box. Of those built of steel sheetpiles, three different types were used. Two were composed of double rows of piling held by rods and walers; one used full circles connected by arcs, while the fourth used two lines of piling driven in a series of catenary curves and connected with steel-pile diaphragms forming elongated cells or compartments. The thickness of the cofferdams varies from 20 to 34 ft., being governed by the height and the

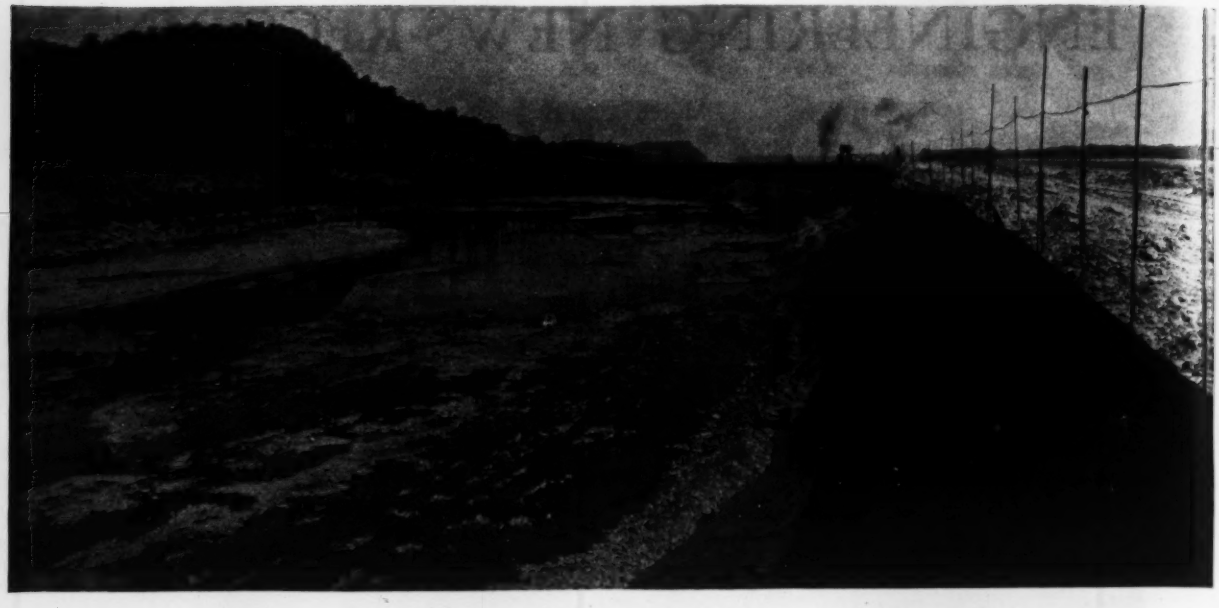


FIG. 2—WOOD-BOX cofferdam located on rock bottom with earth excavation, complete for Mississippi lock No. 22.

preference of the contractor. All cofferdams were filled with river sand readily available at the sites, which was handled generally by pumping with dredging equipment, but also by clamshell derricks.

The area enclosed by a cofferdam for a lock is approximately 1,000 by 350 ft., containing about 8 acres. The height above low water, which is established by the government engineers, is usually about 15 ft. and is designed to afford protection against a flood frequency of approximately one in three average years. The height above river bottom varies with the location from about 20 to 35 ft.

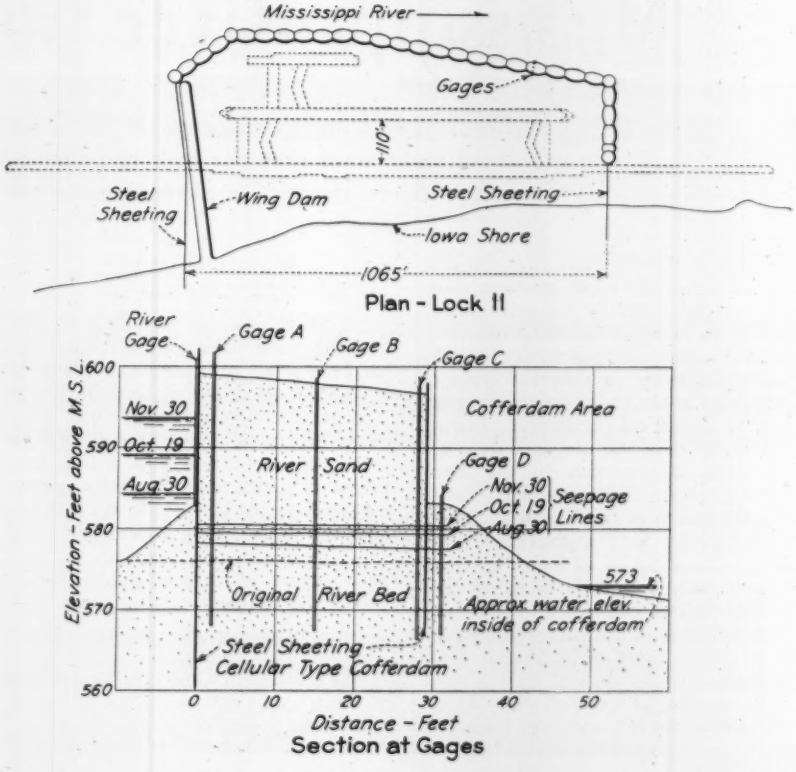
Some observations and studies have been undertaken by the Army Engineers to determine the action and characteristics of the several types of cofferdams under the varying natural conditions encountered. These investigations, however, have developed nothing of a very useful and definite character.

It was well known in the beginning that the effectiveness of a cofferdam on this class of work depended not so much on the type selected as upon natural conditions at the site—namely, the character of the material upon which the cofferdam was seated and the material with which it was filled. An analysis of these questions in advance is helpful in planning the work; but if natural conditions are unfavorable, an effective means of reducing pumpage is not readily available. The quantities involved in filling and banking are so large that the item of cost dictates the use of local material, possibly at the expense of increased pumping.

Upward seepage greatest

Records of pumpage show that when a cofferdam of whatever type is seated on rock or other impervious material, ordinary river sand, either fine or fairly well graded, is very effective in preventing seepage in quantity through the cofferdam. Also, the type of cofferdam selected appears to have little effect on the amount of water handled by the pumps when the cofferdam is located on a sand bottom where an underlying impervious stratum cannot be reached or closely approached. The foregoing indicates that a large part, and probably the major part, of the water to be removed from the average cofferdam seated on sand enters not through or immediately under the cofferdam structure but by upward percolation over the entire enclosed area. In some cases very considerable leakage is observable

FIG. 3—SEEPAGE LINES for cellular cofferdam (lock 11) of steel piles on deep sand bottom.



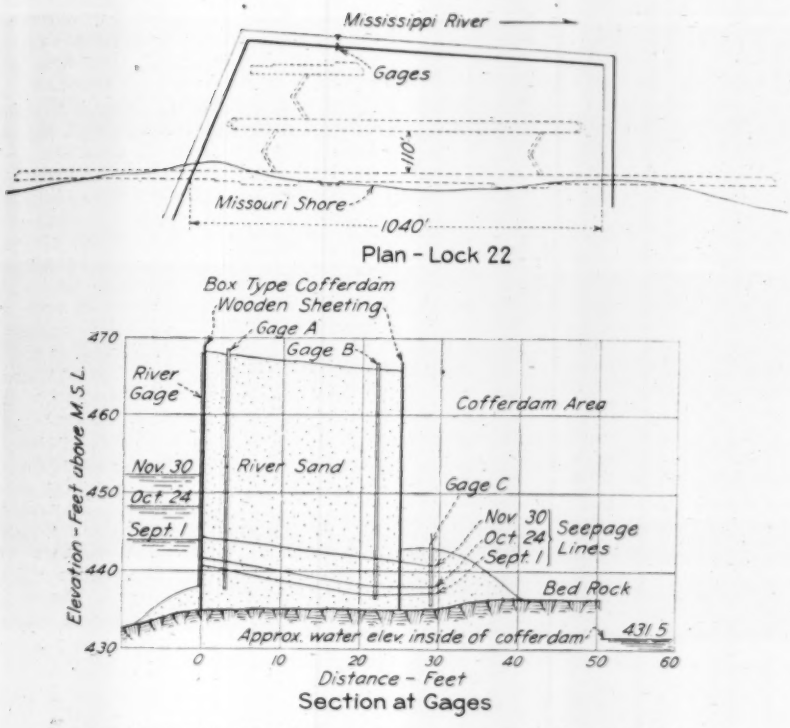


FIG. 4—SEEPAGE LINES for wood-box cofferdam (lock 22) on rock bottom.

along the shore or bank side where the shore constitutes one side of the enclosed area. That much water enters vertically and from a great depth is shown by the fact that after the lock-chamber areas within the cofferdams are completely enclosed by the permanent steel sheetpiling, driven to a depth of some 30 ft. below the natural bed of the river, the leakage inside the sheetpiling remains very considerable and is apparently not materially reduced within this second enclosed area.

Pervious strata subject to boils

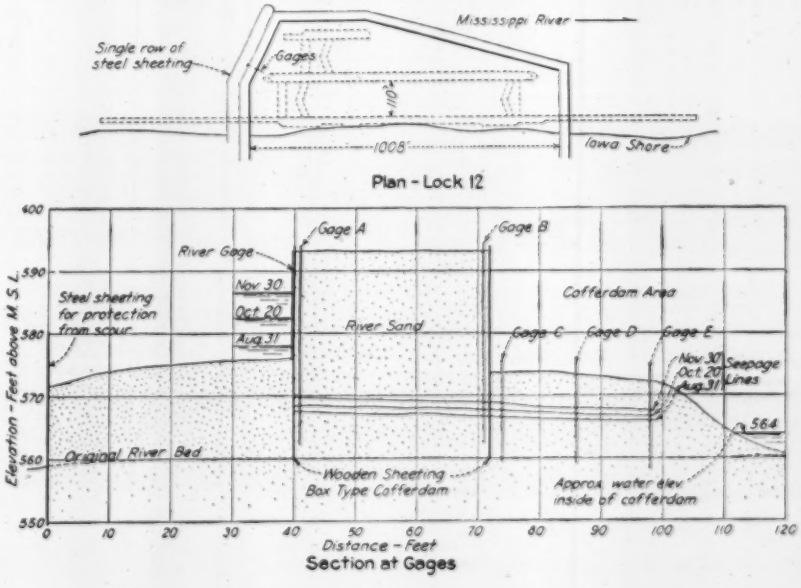
The upward movement of the underlying groundwater frequently appears in the form of sand boils, in some cases of very considerable discharge. These are local concentrations of seepage and are generally harmless in the temporary structures discussed, but should be viewed with suspicion if near the cofferdam structure, since there is the possibility that they may be caused by stratification or buried debris leading under the cofferdam. These boils are not confined to the immediate vicinity of the cofferdam structure, but may appear at any point within the area enclosed.

The belief appears to be generally held that the leakage into a cofferdam enters either through the structure or passes immediately beneath it. This is not correct in the case of the average cofferdam seated on pervious riverbed material of great depth. It is obvious that as soon as the water inside the cofferdam is lowered the unbalanced condition produced is effective in all directions and to a depth reaching some impervious stratum. The area affected will depend on the resistance to the flow of water offered by the material composing the stream bed. Should this material be coarse gravel only, unwatering the cofferdam would be virtually impossible. Fortunately this condition does not occur on the Mississippi River, but considerable variation in the class of material encountered does occur. Sand, and particularly fine sand, offers very little resistance to the upward flow of water because the upward pressure reduces and may overcome the effective weight of the material. This results in the boiling or quickening previously mentioned. This condition may be overcome by the use of well points to intercept the flow before it reaches the surface, but except as previously mentioned, it need cause no uneasiness. If well points are not used, such slopes or banking as may be necessary in the prosecution of the work are difficult to maintain on a leaky bottom, as the sand has a decided tendency to flow. A covering of broken stone or gravel will serve to restore stability.

Seepage-line studies

A line of saturation gages was established, and daily readings were taken on each of eight cofferdams to record the lines of saturation through the structure. Of the eight, only one was seated on impervious material, which in that case was ledge rock. Three representative cases are shown herewith: the cofferdams for locks 11, 12 and 22. These were selected because No. 11 is a steel cellular type on sand foundation. No. 12 is a wooden-box type also on sand, while No. 22 is the rock foundation where a wooden-box type was used. At No. 11 the outer row of steel piling was driven to an average depth of 19 ft. into the riverbed, while the inner row was driven to an average depth of 8 ft. The elliptical cells were 32 ft. wide at the middle and 16 ft. at the ends. The height of the cofferdam was 15.3 ft. above normal low water and 29 ft. above the working grade of the enclosed area. The maximum effective head during the season was 24.7 ft. The heights above low water and effective heads do not vary greatly for the other cofferdams considered. For keeping the working area free of water,

FIG. 5—SEEPAGE LINES for wood-box cofferdam (lock 12) on deep sand bottom.



some of the contractors used well points, while others used surface drainage. At both locks 11 and 12, a combination of the two methods was used. The single row of steel sheetpiling driven near the upstream end of the lock No. 12 cofferdam was for the purpose of deflecting currents and is no part of the cofferdam proper.

As before stated, the particular type of cofferdam selected appears to have less influence on the amount of water to be handled from the working area than do the natural conditions encountered at the site. For this reason the efficiency of the cofferdam structure cannot be judged by the volume of water pumped from it. At low-water stage in the river, at which the effective head on all the cofferdams is approximately the same, the amount of water pumped varied from 1,800 to 20,000 gal. per minute. The minimum was encountered at Lock 22, where the foundation was ledge rock. The length of that cofferdam was approximately 1,700 ft., so that the leakage was only slightly in excess of 1 gal. per foot of length per minute, which necessarily entered through the cofferdam. The minimum pumpage from any cofferdam seated on sand was 5,000 gal. per minute. All others ranged from 10,000 to 20,000 gal. per minute. As above noted, these figures are for low-water stage. There was a material increase at higher stages.

Preliminary investigations of subsurface conditions at the sites consisted of core borings in case of rock and wash borings for other classes of materials. The wash borings were taken on the site of each wall at intervals of about 300 ft. and extended to a depth of about 40 ft. below the wall foundations, the primary purpose being to secure data for the design of pile foundations. Generally, only sand and gravel were encountered, with occasional deposits of clay. It is not practicable to secure a clear and accurate record of underlying sand and gravel stratification by means of wash borings. This, no doubt, accounts for the fact that a study of the records of the wash borings does not provide a reliable basis for estimating in advance the pumpage likely to be required from any giver cofferdam. Nevertheless, such records are a valuable guide and should be given most careful consideration.

Some of the data secured or observations recorded do not conform closely to accepted theories on the flow of water under dams on sand foundations. Conditions, however, are different. When a cofferdam is unwatered, pressures are set up from all directions instead of one. The underlying material is usually distinctly stratified. Should a stratum be open and afford small resistance to the flow of water, almost a uniformly distributed upward pressure results. Obviously, calculated flow and pressure lines cannot apply in such a case. The cofferdam itself is dependable if given lateral stability. It is filled with the same material as that on which it rests and makes perfect contact with the supporting material. There are then no lines of contact for the passage of water that invite piping or roofing. Accidents have occurred under extreme conditions, but this is readily understandable in view of the fact that the ratio of percolation distance to effective head often approaches unity with no cutoff provision at all. The dams defy some of the dam designer's established laws, but nevertheless they serve their purpose surprisingly well.

Welded Steel Pipe Arched Across Unstable Ground

THE USE of welded steel pipe in the form of an arch to cross a stretch of unstable ground in Switzerland has been reported by *Engineering* (London), of July 27, 1934, p. 100. The ground at the point in question consists of clayey calcareous marl and mud, and constant movement occurs. The depth to which the unstable condition applies precluded the use of a tunnel.

The pipe line is used to convey potable water to Lausanne, in the Canton de Vaud. The diameter of the line is 50 cm. The span of the arch is 42 m., and the rise 7 m. It was designed as an arch with fixed abutments and supported at each end by ribs to add to its rigidity. One of the abutments is 2.5 m. lower than the other. They are massive reinforced-concrete monoliths.

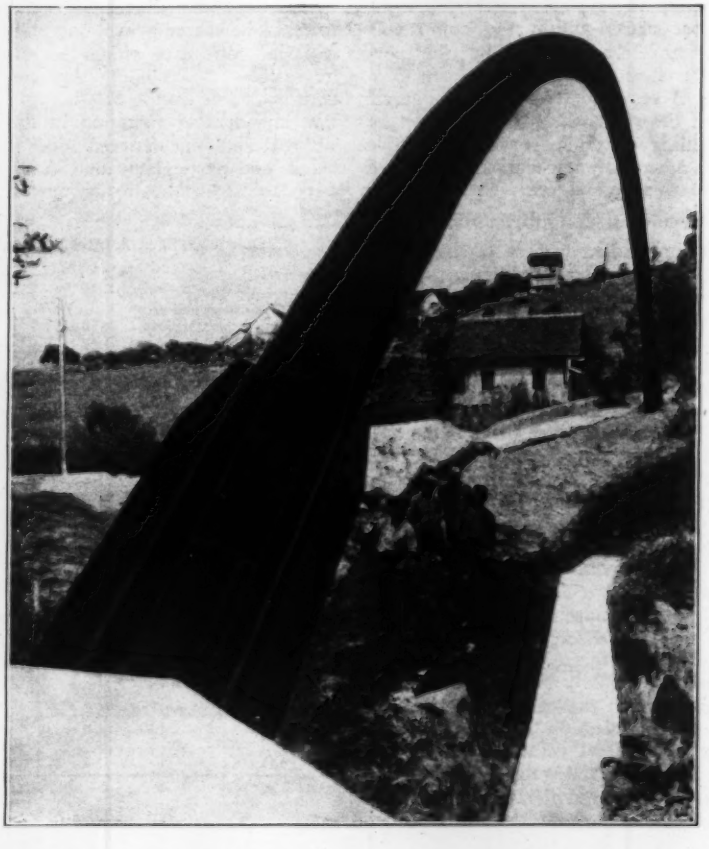
The plates are 12 mm. and 15 mm. thick and 1 mi. long. The thicker plates are used toward the ends.

The plates were joined together in the shop into six sections, varying in length from 2 to 12 m., and these sections were assembled in the field. The assembly of the sections at the center was accomplished by means of a temporary sleeve.

The welds and plate are designed to withstand a working stress of 17,000 lb. per sq.in. The working pressure in the pipe is 29.5 lb. per sq.in. An air valve is placed in the center of the arch.

WELDED STEEL ARCH for carrying water line across a section of unstable ground in the Canton de Vaud, Switzerland.

Courtesy of Engineering (London)



Construction, Subsidence and Repair of San Gabriel Dam No. 2

Rockfill dam 265 ft. high settles 12 ft. following torrential rain —Concrete facing damaged—Consulting board recommends repairs with temporary timber facing—Reconstruction described

FIG. 1—SAN GABRIEL DAM NO. 2 under construction, showing upstream facing slab starting near the toe, placed-rock section and main rockfill being placed by trucks using road at left leading from quarry. The spillway is at the right.

A GENERAL REVIEW of the program of the Los Angeles County Flood Control District on the San Gabriel River was published in the issue of Jan. 24, p. 113. That article described preliminary construction work and the present status of Dam No. 1, a rockfill structure, to provide the main control reservoir. The additional storage required for necessary regulation on the river is provided upstream at another rockfill dam (No. 2) on the west fork. The construction of this dam, subsequent settlement and present repair work are described in this article. —EDITOR.

AFTER comparison of various dam sites in both forks of San Gabriel Canyon, some years ago the decision was reached by the flood control district that in addition to Dam No. 1 the only other location offering a desirable storage capacity and also a suitable dam site was at a point on the west fork about 11 miles upstream from the confluence of the east and the west forks.

This location was approved for a rockfill dam 265 ft. high, 580 ft. long on the crest and 750 ft. thick at the base, to contain a total of 1,117,000 cu. yd. of rock and to be known as Dam No. 2. The reservoir storage capacity is 13,000 acre-ft. Contract for the construction of this dam was signed with the Macco-Lewis Construction Co. on April 7, 1932, at a price of $2,086,950 (engineer's estimate $2,917,520); the contract called for completion April 6, 1934.

Previously, in order to speed up construction operations, a separate contract had been made for the outlet tunnel, a bore 1,060 ft. long with a diameter of 14 ft. inside the concrete lining, driven through rock around the right abutment. This tunnel was designed to serve as the bypass for streamflow during construction and ultimately as the main regulating outlet. The tunnel traversed good rock; only about 15 per cent of its length was required to be timbered. Its average cost including the lining was $71.50 per foot.

Preliminary work

Preliminary excavation on the abutments for the dam, done by sluicing with a hydraulic giant (*ENR*, Sept. 15, 1932, p. 311) removed about 50,000 cu.yd. of overburden. The remainder of the material to be excavated was barred down in 25-ft. lifts, loaded into trucks by power shovels and hauled upstream from the site. The total overburden removed was about 150,000 cu.yd.

Cutoff trenches were excavated into the solid rock. They were 5 to 10 ft. wide and extended down to a maximum depth of 35 ft. into bedrock. The engineer's report says, "Since the lower 100 ft. in elevation of the upstream face of the site above streambed was located on steep faces, practically vertical on both abutments, the excavation of these trenches was the most difficult construction problem on the work. In some locations the trenches were deep inclined slots in the steep hillside constructed in short alternate sections each immediately filled with concrete."

Quarry and rockfill

The quarry was located about 2 miles upstream from the dam on a tributary known as Devil's Canyon. The rock developed at this site was reported to be excellent and weighed an average of 175 lb. per cu.ft. as compared with minimum specification requirements of 160 lb. Roads were constructed by the contractor from the quarry site, and the first rock in the dam was placed on July 13, 1932. Specifications required the placing of rock in 25-ft. lifts, which was expected to result in less ultimate settlement than if higher lifts had been used.

Reports by the chief engineer indicated that the settlement during the placing of the rock was about 1 ft. per lift during the time of placing. Truck hauling on the top of each lift was facilitated by the placing of a few inches of fine material on the rock surface; this material was loosened by scarifying with a three-tooth rooter after each lift had been completed in order to bond with the succeeding lift.

For the upstream slope the specifications required a derrick-placed facing (Fig. 2) with a maximum horizontal thickness of 25 ft. at the base and 10 ft. at the crest. Over this rock facing was poured a concrete sub-slab with a minimum thickness of 6 in. Thin laminated layers of reinforced Gunite 6 in. thick were put on over the sub-slab; four layers were used at the base of the dam and two at the top.. The concrete sub-slab, divided into panels 30 ft. square, each hung from concrete-filled keyways provided in the derrick-placed rockfill for the purpose, was placed over a total of about 150,000 sq.ft. On the downstream face of the dam (Fig. 3) the rockfill was placed on slopes of 1.3, 1.5 and 1.6 to 1.

The spillway (Fig. 3) consists of a notch in the right abutment removed about 100 ft. horizontally from the dam. It involved a cut with a maximum depth of 120 ft., a base width of 140 ft. and a length of 250 ft. Discharge from the spillway is by means of an inclined concrete chute to streambed. Outlets from the reservoir at six elevation discharge through sloping tunnels into the main outlet tunnel.

During the summer of 1933 work progressed rapidly on Dam No. 2, and three shifts were employed. For some time rock was placed in the dam at the average rate of 3,000 cu.yd. per day. On July 1, 1933, a total of 615,000 cu.yd. had been placed, and there remained 385,000 cu.yd. to be brought in.

In December, 1933, and January, 1934, after heavy rains, considerable general

settlement occurred, notably in the upper part of the dam, causing the concrete facing to slump and crack badly. Although exact records are not available, the total vertical subsidence amounted to about 12 ft. Some engineers have ascribed this settlement in part to the torrential downpour that occurred throughout this general region on Jan. 1, 1934. Others held the opinion that a properly constructed dam could not show any such settlement regardless of rainfall. Early in 1934 major work on the dam was stopped to study the settlement question. The contractor had relatively little more work to do, and there was no claim that he had not complied with specifications. A final settlement was made with him, therefore, and the district took over responsibility for further work on the structure. Settlement points were established and nearly continuous settlement readings were taken beginning Dec. 12, 1933.

The Gunite facing slabs were so badly distorted and out of line in places that remedial measures of some sort obviously would be necessary. Accordingly, in June, 1934, a consulting board consisting of L. F. Harza, R. J. Reed and I. C. Steele was retained. On Aug. 25, 1934, this board submitted a report from which the following has been abstracted.

The Harza-Reed-Steele report

The special consulting board found that:

> The slopes of the rockfill as designed are conservative, and the rock is of sufficiently good quality for a dam of this type. It appears, however, that a deficiency of significant rainfall and the absence of artificial wetting ("sluicing") for settling purposes during the placement of the rockfill has resulted in an abnormaly large settlement subsequent to the construction of the concrete facing slab. This has caused cracking and displacement of a large portion of the facing slab, which will, in our opinion, necessitate its practically complete reconstruction.

The report then turns to emergency considerations and finds that with normal rainfall probably the dam would be safe in its present condition through the coming winter if all outlet valves were left open. An extreme flood, however, might fill the reservoir even with valves open; to avoid the danger this would entail the board recommended, after the cracked facing has been removed:

> The construction of a temporary, flexible wooden face which can be readily completed before danger of floods, and which will insure safety of the structure and permit storage of water. This procedure is justified not only by its value in making the reservoir immediately ready for the use for which it was intended but also by the value to be gained through settlement resulting from the water pressure against the dam.

FIG. 2—Upstream face with the placed rock section advanced to near the top of the picture and the poured sub-slab following.

The report summarizes its own recommendations for immediate work in four items:

1. The placing of additional rock at the crest and on the downstream slope to build up certain deficient areas and to allow for such additional settlement as can be now contemplated.
2. The continuation of sluicing operations so long as they do not interfere with the construction program herein outlined and so long as the resulting settlement of the rock is sufficient to justify such work.
3. The removal of practically all concrete slabs down to the sub-slab.
4. The construction of a temporary timber face over practically the entire upstream surface of the dam, this structure to be provided with adequate fire protection, and also with facilities for distributing to the underlying rock through valve-controlled openings, water in sufficient quantity to accomplish a substantially complete settlement.

Ultimately, the report advises, more rock may be required on the downstream slope and along the crest of the dam, the removal of the temporary timber face to be followed by construction of a reinforced-concrete face yet to be designed and the improvement of a certain portion of the right abutment cut-off. If this program is followed, the engineers believe the dam would be permanently safe and satisfactory.

Sluicing operations mentioned in recommendation No. 2 were begun in early summer and were continued for several months in an endeavor to compact the fill. Jets of water were applied both on the up and downstream faces by pumping the total natural flow from the stream. This flow amounted to about 2,800 g.p.m., which was divided more or less equally between the two faces. On the upstream side holes were cut through the concrete facing, spaced 15 ft. on centers both ways— *i.e.*, four holes in each 30-ft. slab—and water was pumped simultaneously through four adjacent slabs (sixteen holes) so long as observations on the slab face (with transit) showed settlement. On the downstream face pipes for jetting were laid in the rocks, and seepage was caught in a tailwater dam below the downstream toe and recirculated.

Present situation at Dam No. 2

In general accord with recommendations of the consulting board, a contract was awarded to the Case Construction Co. on Oct. 8, 1934, for removing all

FIG. 3—DOWNSTREAM FACE, showing blanket of massive rock designed to add weight and stability. Final height of the structure is indicated by the spillway notch at the left.

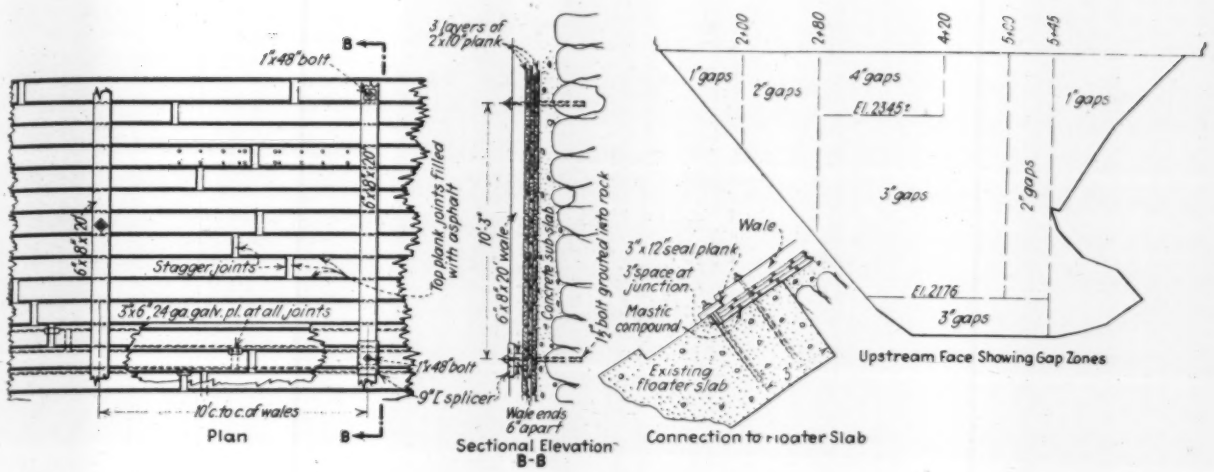


FIG. 4—FEATURES of temporary timber facing being placed on poured concrete sub-base after removal of Gunite slabs. Expected settlement is provided for by the gaps between plank ends shown in the plan at the left.

the laminated Gunite facing, totaling 12 in. in thickness at the top and 24 in. at the base, and placing a timber facing over the entire concrete sub-slab. Also, it was decided to place such additional rockfill as is necessary to restore and complete the dam to a cross-section substantially the same as that originally planned, which will require about 60,000 cu.yd. On Nov. 13, 1934, a contract was awarded to Macco Construction Co., and work is now under way.

As a practical matter, the construction of the facing slab was undertaken in two steps in order that the winter's runoff could be stored. The first step consisted of the removal of slabs and construction of the facing slab up to El. 2176, which provides sufficient pondage to divert the natural streamflow through the tunnel. This portion of the facing was backfilled with earth to afford protection. After this unit was completed, the contractor then proceeded to remove the necessary facing slabs and construct a new timber facing in any sequence he saw fit, inasmuch as these operations would not be affected by flows in the river. The only limit placed on his operations was that in general the timber facing should be placed from the lower reaches of the dam upward toward the crest.

In the main, the timber facing consists of three layers of 2x10-in. planks, laid horizontally across the face of the dam and fastened down by wales bolted to the rock beneath, as shown in Fig. 4. Gaps of 1 to 4 in. are left between plank ends (the spacing varying according to location on the dam) to allow for expected settlement of the rockfill beneath. The width of the gaps was made to correspond with previously observed settlement of the fill; the maximum settlement, of course, occurred at the top center, and here the gaps were made widest.

Around the edges of the facing some pulling away from the abutments was expected, such as would increase the gap spacing. If allowances fit conditions perfectly, any further settlement of the dam will decrease the width of gaps at the center and increase those at the abutments; thus ultimately the gap widths over the entire facing will tend to equalize. However, in the last four months of 1934 the total settlement recorded was less than 0.1 ft., and none occurred after the December storm, which brought the heaviest rainfall in many years.

The spacing between the edges of the planks was ¼ in., a constant for the entire facing. To facilitate maintaining this spacing, roofing tacks driven into the plank edges were left projecting ¼ in.

Planks are delivered in assorted lengths, are sorted into piles of the same length, and from each pile three-layer units resembling Wakefield sheetpiling are made up. Thus construction of the facing becomes a process of assembling pre-fabricated units of different lengths. Over the finished timber facing hot asphalt is mopped on, and care is taken to fill the end gaps and edge spacings of the top layer. Gaps and edge spacings for all three layers are the same.

Parking Area at Low Level Protects Ocean View on Coast Route

ALONG the California coast route north of Santa Monica, where large numbers of cars park along the edge of the roadway overlooking the surf, a plan of construction has been followed which permits the maximum use of parking area and at the same time leaves unobstructed a view of the ocean for vehicles moving along the highway. This has been accomplished by separating the highway proper from an auxiliary unpaved roadway on the ocean side of the pavement at an elevation about 5 ft. lower than the paved highway surface. No parking is allowed on the paved highway, but at frequent intervals entrances to the lower road make it convenient to turn off and park along the edge of the embankment.

LOWERED ROADWAY with parking area on ocean side of coast highway. Note access ramp in right background.

Jacking 5-Ft. Concrete Pipe Under Railway Fills

Cost analysis of jacking 60-in. precast-concrete sewer pipe a total of 212 ft. under two railway embankments at Rutland, Vt.

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THE RECONSTRUCTION in 1934 of the Moon Brook sewer, which serves the southern part of the city of Rutland, Vt., included large-diameter pipe-jacking operations under two railway embankments. A careful analysis of the costs of these jacking operations was made and is presented here as an indication to others of jacking costs when various possible tunneling methods for penetrating embankment are being estimated. Rather complete itemization has been undertaken to make comparisons accurate, and for the same reasons the construction conditions are described in some detail. It is as a record of useful cost determinations that the description of the work has particular value.

Old and new sewer

When the original Moon Brook sewer, an 18-in. pipe was built, there was only one embankment to go through. On one branch of the railroad the tracks were on a short trestle, and the sewer passed under the trestle. This trestle was later replaced by a fill. The 18-in. pipe was put through the other embankment by digging a tunnel and lining it with timber as it was dug. The pipe was laid in this tunnel, and the space was backfilled. At that time, 1897, the embankment was not as wide as at present, as it carried only two instead of three tracks.

The designs for the new sewer called for 60-in. reinforced concrete, extra-strength pipe, to be jacked under the two railroad embankments. These jacked sections are part of a system which consists of 782 ft. of 4x6-ft. box-section sewer, 3,431 ft. of 60-in. circular sewer, all of these two sections to be monolithic concrete except the jacked sections, and 4,092 ft. of precast reinforced-concrete pipe of 48-in., 42-in., 30-in. and 36-in. sizes.

Methods for first operation

The first jacking job was started May 14, 1934, with the digging of a jacking pit at the toe of the west slope. As this west bank contained large marble blocks, a short section of timbered tunnel was dug into the bank until it had passed through this marble. Actual jacking was started on June 18; the crew averaged about seven men and a foreman, and the working week was of six days of 7½ hours. The make-up of the crew had to be such that no man worked more than a 30-hour week in accordance with PWA regulations.

The jacking pit was about 10 ft. long and 8 ft. wide, the sides being supported by tight 2-in. sheeting. Rails were laid on the bottom embedded in concrete, to form a guide for the pipe being jacked. Two 100-ton ratchet jacks furnished the pushing power. As the 60-in. monolithic concrete pipe had already been built up to the jacking pit, a backstop for the jacks was built by laying up timbers against the end of this completed pipe. Over the pit an 8-in. I-beam, supported at the ends, carried a trolley with a chain falls. This was used to lower and place the 5,000-lb. sections of 60-in. reinforced-concrete pipe and to raise the wheelbarrows loaded with dirt being removed from the pipe.

The grade of the pipe was such as to bring the top just under the railroad fill; the excavation consisted of gravel, sand and topsoil, and the grade of the bottom was just on the top of a layer of clay. As the sewer paralleled Moon Brook, below its water level, and was adjacent to the old 18-in. sewer, from which there was some leakage, it was necessary to pump the water from the excavation; however, groundwater conditions were not as bad as had been anticipated.

The procedure was to have one man digging at the head end of the pipe and another clearing the dirt away from the digger, loading it into a wheelbarrow and wheeling it back to the jacking pit where it was hoisted out. Two men operated the jacks; the rest of the crew hoisted the dirt out of the pit, disposed of it, pumped water, handled jacking timbers and did miscellaneous small jobs. A timber ring (Fig. 1) protected the end of the pipe and distributed the push of the jacks. The jacks could be run out 11 in., at which point it was necessary to release them and add jacking blocks. This process was repeated until the pipe had been pushed 4 ft., and then another pipe was added.

During the process of jacking, various obstacles were encountered, such as timber mats and structures of uncertain origin, possibly the old timber trestle. These were cut out as fast as they were exposed by excavating around them. The digger at the head of the pipe kept the hole a fraction of an inch larger than the pipe all around. There was no trouble with the dirt face, and no shield or cutting ring was used.

At first, softwood jacking timbers were used, but it was necessary to replace these with oak. Work progressed at a rate varying from about 6 ft. per day at the beginning to 3 ft. or less per day after the pipe was well into the bank. When twelve pipes had been pushed in, the jacking became very difficult, and by the time the thirteenth pipe was put in the 8x10-in. oak jacking timbers were crushing, and it had be-

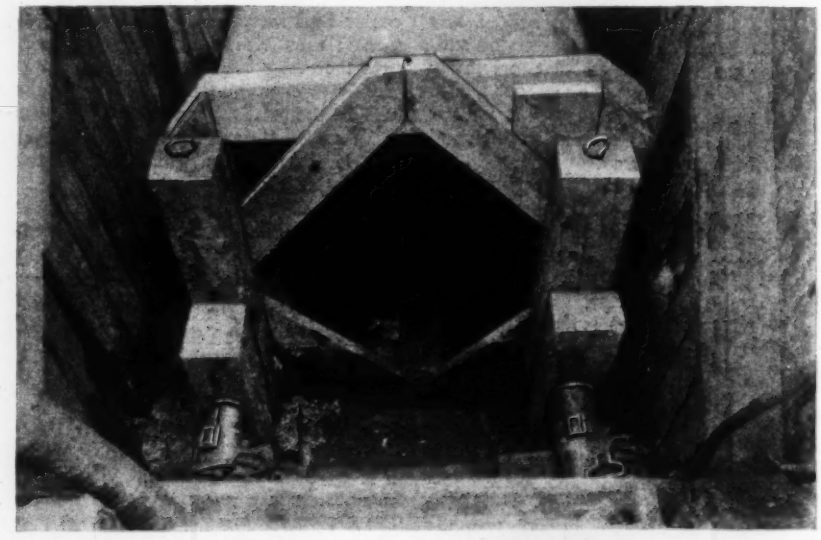


FIG. 1—TIMBER RING conveyed pressure of two 100-ton jacks to end of pipe line being jacked under embankment.

come necessary to work two men on each jack handle. As the pipe had by then passed under two tracks, it was decided that both speed and economy would be gained by jacking back from the east side and making a closure under the bank. This was done and proved true; the jacking was much easier, and when eight pipes had been put in the joint was closed without difficulty, the line and grade having been checked frequently enough to insure this. In all, 21 pipes (a total of 84 ft.) had been jacked. The spaces in the jacking pits were closed up, using the same kind of precast pipe, and the section of 60-in. sewer was completed and ready for service on July 14. During the entire period of construction there had been no interruption of railroad traffic—in fact trains passing overhead were not even subject to slow orders.

Cost of first operation

The labor costs for this section are contained in Table I. This cost includes backfill of jacking pits, pumping, laying pipe in jacking pits, and all miscellaneous operations connected with this part of the project. The equipment purchased was as follows:

Wheelbarrows	$7.48
Hardwood timber	34.23
I-beam	9.88
Trolley	20.70
Pipe-lifting hook and repairs	32.21
Saw	1.13
Total	$105.63

As this equipment was to be used for the other jacking operation described later, not more than about 25 per cent of it (or $26.41), can be charged against this first section. The lumber for sheeting, etc., the small hand tools and a very small amount of other equipment were used repeatedly on the major project, and their depreciation on this jacked section was very small. A reasonable sum for their use and also a fair amount for engineering and inspection would be covered by about $75. The total cost is then shown to be:

Labor	$1,660.35
Pipe, 96 ft. @ $7.63	732.48
Equipment depreciation	26.41
Overhead	75.00
Total cost	$2,494.24
Cost per foot	$25.98

The estimated cost for this jacking job was $54 per foot. No estimate was made of the cost by the open-cut method, but it is obvious that it would be several times the cost of jacking.

Methods for second operation

The second jacking operation was started July 16 with the digging of a jacking pit at the east foot of the embankment. Like the previous job, the grade of the pipe was almost entirely under the original ground surface. This east side of the embankment consisted of loose sand, and some difficulty was encountered in constructing the pit.

FIG. 2—CLOSURE being made of pipe lines jacked from opposite sides of embankment.

Pipe jacking started July 26 with a crew of seven men and a foreman working a 45-hour week, with the laborers shifting so as not to exceed the 30-hour-week regulations. The procedure was practically the same as before. Progress, however, was much more difficult than on the previous work. The soil was clay with embedded boulders, and it was hard to remove these boulders from around the circumference of the pipe. The soil was damp and had a tendency to cave at the head end of the pipe, and frequent heavy rains kept the ground wet and more difficult to dig. The old sewer as previously stated had been built in a timber-lined tunnel, and many of the old timbers projected into the excavation for the new pipe and had to be cut out. The greatest difficulty, however, was caused by a cavity over the top of the old timber tunnel. Obviously, the dirt had arched over this space, so that as the new construction progressed, its stability was disturbed and the embankment settled. This movement caused caving just at the head of the pipe and slight settlement of the tracks above.

Another peculiar development was that the new pipe kept working upgrade. The only explanation is that with the wet clay underneath and a small cavity above the pipe at the head end, the pipe was forced upward. This was overcome by putting a jack at the head end of the pipe, pushing against the bottom to force it down as it moved forward.

TABLE I—COST OF FIRST JACKING OPERATION OF 96 FT. OF PIPE

	Hours	Labor Total
Breaking up heavy marble rip-rap	47½	$23.75
Short tunnel, west side	131½	65.75
Preparing pit, setting rails	38½	22.35
Excavating, removing dirt, etc.	1,040½	520.25
Jacking, etc	1,333½	800.25
Supervision	282	228.00
Total labor	2,876½	$1,660.35
Labor cost per foot (96 ft.)		17.30
Cost of pipe delivered on job		7.63
Labor and material per foot		$24.93

Movement became slow and very difficult when eight pipes, or 32 ft. were in place. On Aug. 8 a second labor shift started working in an attempt to keep the pipe moving; this made a working day of fifteen hours. The use of the timber ring at the jacking end of the pipe was abandoned, and in its place two heavy vertical timbers, one for each jack, were placed so as to get maximum bearing surface at the end of the pipe. Jacking was stopped Aug. 16 when eleven pipes had been pushed into the bank. A bulkhead was built at the head end to prevent caving, two pipes were placed in the jacking pit and the hole was backfilled.

Work was not started immediately on the west side because a section of 60-in. monolithic pipe was being poured, and it was necessary to wait until this was finished so that it could be used as a backstop. The jacking pit was built from Sept. 19 to 25, and jacking was started on the last date. The first pipe carried a steel shield that projected 18 in. beyond the pipe and extended around the upper half of the circumference. This was intended to prevent caving and protect the digger at the head end of the pipe. It did fulfill both of these expectations, but when obstructions were encountered it increased the difficulty of removing them.

While jacking from this side, which was the downstream side of the embankment, the pipe had a tendency to settle below grade. This was just the opposite to the difficulty encountered from the upstream side. Again the trouble was corrected by means of a jack at the head end pushing the pipe up as it moved forward.

Although the ground on this side of the embankment was dryer and caved less, it was very difficult excavation. Very large boulders were encountered. These were broken up by heating with oil-burning torches. As before, the pushing became difficult after the eighth pipe had been added. When eleven were in place the movement was very slow. Frequent heavy rains kept the pipe on the east side of the embankment filled with water at intervals. Work was suspended on the west side at such times as there was danger of the water washing through and trapping the workmen at the face.

During one of these periods on Oct. 22 the dirt that remained between the east and west pipes washed out in the form of a hole the size of the pipe. The ends of the pipe were about 8 ft. apart. Three shifts of men were put on to work continuously to close up the gap before caving started. On Oct. 23 jacking became so difficult that it was obvious that the extreme load limit of the jacks had been reached. The pipe ends were then 6 ft. apart. Jacking was stopped, the opening was sheeted with

plank, a form was set, reinforcing was placed, and the concrete for the invert and sides of the pipe was poured. The top was placed by shooting, completing the pipe.

The alignment of the pipes from the east and west sides was perfect when the dirt washed through, so that the joining of the two ends was comparatively easy. Two pipes were placed in the pit, and the line was completed Nov. 1, a distance of 116 ft.

Cost of second operation

The cost of labor and supervision is shown in Table II. The only new equipment purchased was as follows:

Hardwood timber	$39.21
Steel plates	14.66
Pulley block	2.83
Electric bulbs	1.06
Glass	.25
Carbide	3.26
Broom	.90
Electric cord	2.33
Total	$64.50

As this equipment is to serve for future jacking work, not more than one-third of the above, or $21.50, should be charged to this crossing. Also 25 per cent of the material listed in the report of the first jacking job should be charged. The allowance for overhead, engineering and inspection should be about the same as for the first section. The total cost, therefore, would be:

Labor and supervision	$2,889.75
Pipe, 116 ft. @ $7.63	885.08
Equipment, 25% of first list	26.41
Equipment, 33⅓% above	21.50
Overhead	75.00
Total cost	$3,897.74
Cost per foot	$33.60

To arrive at a true average cost for all the work that has been done so far, the two crossings should be combined:

Bennington Division	$2,494.24
Bellows Falls Division	3,897.74
Total cost	$6,391.98
Average cost per foot for 212 ft	$30.15

Discussion

From these reports it is obvious that speed was not developed on this operation. The reason was that since construction on the Moon Brook sewer project was to last about a year there was no need for completing the jacked sections quickly. By keeping the work going continuously with enough labor shifts the elapsed time could have been reduced.

The cost of this construction by the jacking method has proved conclusively that it is much cheaper than the open-cut or the conventional tunneling methods for such embankments.

The distance that can be jacked depends on the equipment and the strength of the pipe being pushed as well as the solidity of the backstop. About 50 ft. is obviously the limit under a railroad embankment for a jack capacity of 200 tons and jacking blocks of oak or maple. There is no doubt that the vibration resulting from fast heavy trains keeps the dirt packed solidly around the pipe, thus greatly increasing the frictional resistance.

TABLE II—COST OF SECOND JACKING OPERATION OF 116 FT. OF PIPE

Item	Constr. Hr.	Labor Cost	Supervision Hr.	Supervision Cost
Move over and dig pit, east side	502½	$301.50	53½	$42.80
Jacking—1 crew, east side	629½	377.70	87½	70.00
Jacking — 2 crews, east side	846½	507.90	128½	102.80
Backfill—east side	45	27.00	7½	6.00
Move equipment to west side	45	22.50	7½	6.00
Dig pit, west side	229	114.50	38	22.80
Jacking, west side	1,460½	876.30	230½	184.40
Gunite	39	38.35	50	50.00
Pour concrete	40	24.00	23	18.40
Clear out pipe	52½	31.50	15½	15.50
Backfill pit	83	49.80	....	.....
	3,972½	$2,371.05	641½	$518.70

Total: 4,614 hrs.—$2,889.75

Length of pipe placed	116 ft.
Cost per foot, less pipe	$24.91
Cost of pipe	7.63
Labor and material per foot	$32.54

The precast concrete pipe used on this project was manufactured in Rutland, Vt., and delivered to the job by the Reinforced Concrete Pipe Co., Inc. The 60-in. pipe was designed and built to conform to the A.S.T.M. specifications for extra-strength pipe. The concrete mix used was: 1 cement, 1½ sand and 2 stone. To obtain high early strength and permit the removal of forms within a short time, high-early-strength cement was used. Each 60-in. pipe contained 140 sq.ft. of 3x12-in. mesh, ¼-in. wire, weighing 4.16 lb. per sq.ft. The wall thickness of the pipe was 6 in. Each 4-ft. length weighs a little over 5,000 lb. The lap joint that was used insured a smooth exterior surface after pipe was joined and thus presented the least possible resistance to pushing.

The engineering organization consisted of Edw. L. Tracy, designing and supervising engineer; W. K. Nichols, assistant engineer; J. McLaughlin, general sewer foreman; and John Connor, construction foreman, all working for the city. Edw. Leahey was PWA inspector.

Status of Locks and Dams for Upper Mississippi River Improvement

THE ESTABLISHMENT of a 9-ft. navigation channel on the upper Mississippi River between St. Louis and Minneapolis requires the construction of 27 dams and accompanying locks. The first of these, at Keokuk, Ia., was completed in 1913. Dam No. 1, at St. Paul, was built in 1917; Dam No. 2, at Hastings, Minn., was completed in 1930; and a fourth, at Rock Island, Ill., was built in 1933. Of the remaining 23 locks, three were completed in 1934 and thirteen more now under construction are scheduled for completion this year. Four dams are now under construction and contracts have recently been awarded for three more, with bids called for last month on another one. Funds for all of the recent works have come from PWA allotments. To complete the program, seven more locks and fifteen dams are required, for which no funds are available at present.

The entire lock and dam program is being carried out under contract by the U. S. Engineer Corps of the St. Louis, Rock Island and St. Paul districts. The accompanying table shows the status of the whole program.

STATUS OF CONSTRUCTION OF LOCKS AND DAMS, UPPER MISSISSIPPI RIVER, ST. LOUIS TO MINNEAPOLIS

No.	Location	Status Dec. 1, 1934 — Locks — Per Cent Complete	Locks — Completion Date	Dams — Per Cent Complete	Dams — Completion Date
1.	St. Paul, Minn	100	1917	100	1917
2.	Hastings, Minn	100	1930	100	1930
3.	Red Wing, Minn	.....	.....	.....	.....
4.	Alma, Wis	100	1934	89	April, 1935
5.	Fountain City, Wis	100	1934	79	May, 1935
5A.	Winona, Minn	95	Feb., 1935	Awarded Jan., 1935	
6.	Trempealeau, Wis	97	Feb., 1935	10	May, 1936
7.	Dresbach, Minn	90	Mar., 1935	.....	.....
8.	Genoa, Wis	99	Feb., 1935	.....	.....
9.	Lynxville, Wis	91	Feb., 1935	.....	.....
10.	Guttenberg, Ia	81	Feb., 1935	Awarded Jan., 1935	
11.	Dubuque, Ia	74	Feb., 1935	.....	.....
12.	Bellevue, Ia	70	Feb., 1935	.....	.....
13.	Clinton, Ia	.....	.....	.....	.....
14.	Le Claire, Ia	.....	.....	.....	.....
15.	Rock Island, Ill	100	1933	100	1933
16.	Muscatine, Ia	95	Feb., 1935	Awarded Dec., 1934	
17.	New Boston, Ill	.....	.....	.....	.....
18.	Burlington, Ia	93	Mar., 1935	.....	.....
19.	Keokuk, Ia	100	1913	100	1913
20.	Canton, Mo	100	1934	57	July, 1935
21.	Quincy, Ill	91	Jan., 1935	.....	.....
22.	Saverton, Mo	87	Jan., 1935	.....	.....
23.	Louisiana, Mo	.....	.....	.....	.....
24.	Hamburg, Ill	.....	.....	.....	.....
25.	Cap Au Gris, Mo	.....	.....	.....	.....
26.	Alton, Ill	43	Sept., 1935	Bids Feb., 1935	

Note: Blank spaces indicate funds are not available at present for these projects.

What Is Known of Aggregates for Road Surfaces?

The new thinking and increased investigation being devoted to the study of aggregates for bituminous and concrete road surfaces as outlined in an interview given by F. H. Jackson, Bureau of Public Roads

WITH 75 to 90 per cent of all road surfaces, whether bituminous or portland cement mixtures, composed of mineral aggregates, the quality and activity of these aggregates are critical considerations to the road-builders. What are the qualities desired of an aggregate for road surfacing? What properties of hardness, toughness, inertness, gradation, inherent stability, compactability and adhesiveness to binders should a good aggregate possess? And finally what advances have been made in means for determining these properties? Answers to these questions were sought at the Arlington testing fields and laboratories of the Bureau of Public Roads, and inquiry produced the following review of current knowledge and experimentation by F. H. Jackson, senior engineer of tests.

Have our studies of aggregates been inclusive enough to give us a commanding knowledge of the rôle that they play in paving mixtures?

► It has only been within recent years that much attention has been paid to the influence of such physical characteristics of aggregates as shape, surface texture, mineral composition, absorption, etc., our efforts having been concentrated largely on the effect of variations in grading and its relation to the design of the mixture. This applies to both the portland-cement concrete and the bituminous road fields.

As an illustration of this, we have the theory so long promoted in the concrete field that the quality of the mix is not influenced by variation in the quality of the aggregate just so long as the material is sound and durable. This theory places the emphasis entirely on gradation and its effect on the economy of the mix. Likewise in the bituminous field, the conventional theories of mixture design deal only with the effect of grading, and most of the experiments conducted in stability have been concerned only with this variable.

However, it is becoming more and more evident that certain observed differences in the behavior both of portland-cement concrete and bituminous mixtures can only be accounted for by differences in aggregate characteristics other than gradation. For instance, the tendency of a concrete pavement to form contraction cracks seems to be tied up very intimately with the kind of aggregate used. Whether this is due to differences in tensile strength or coefficient of expansion is a question. It has been shown that each of these properties is affected to a marked degree by the kind of aggregates used. Likewise, in bituminous work, experience has shown that certain characteristics of mineral fillers other than size greatly influence the stability of the pavement. The question has also been raised as to the significance of the time-honored tests for quality of stone as a real measure of the value of the material as bituminous aggregate. Much interest is being manifested at the present time in these and other problems of a similar nature—all bearing upon the general question of how to make the most efficient use of these materials in the construction of roads.

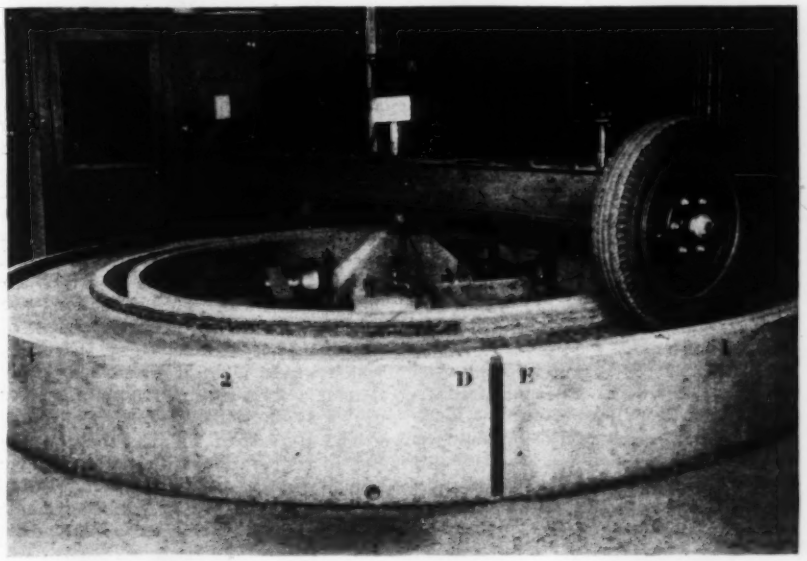


FIG. 1—CIRCULAR TRACK for testing road surfaces at the Arlington experiment station of the U. S. Bureau of Public Roads.

Considering, first, aggregate quality for bituminous mixtures, are the present abrasion and toughness tests adequate?

► One of the problems confronting users of aggregates for bituminous work at the present time is that of devising a more satisfactory routine acceptance test for quality. Engineers are virtually unanimous in deploring the inadequacy of the present specification tests for acceptance, such as the Deval abrasion test and the standard toughness test. This has been reported from several sources and has recently received experimental verification through a series of tests on crushed stone from various sources conducted by Goldbeck and reported before the American Society for Testing Materials in June 1934 (A.S.T.M. *Proc.*, Vol. 34, Part II). He shows that there is virtually no relation between the results of the standard abrasion test and the resistance of these same materials to crushing under a roller. These tests were conducted on a circular track 14 ft. in diameter constructed in the laboratory. The pavement sections comprising the track may be subjected either to the action of a roller when testing the aggregate alone, or to a pneumatic tire when investigating surfacing mixtures.

In connection with roller tests for quality of aggregate, reference should be made to the work done by the state highway department of Georgia. In this case, a hand roller is passed a definite number of times over a layer of the aggregate spread on a metal-lined runway, and the change in size is used as a measure of quality (*Rock Products*, Jan. 17, 1931).

The circular track test used by Goldbeck is representative of a number of similar devices that have been constructed recently. Equipment of this type possesses great possibilities for the rapid investigation of road paving mixtures. It comes nearer to fulfilling the requirements for an accelerated test than anything yet devised. It is possible to investigate the behavior of the mixture under a wide variety of controlled moisture and temperature conditions. Furthermore, in the apparatus constructed by the Bureau of Public Roads and described by Carpenter before the 1933 annual meeting of the Association of Asphalt Paving Technologists (*Proc.* Assoc. Asphalt Tech,. December, 1933), provision is made for laying the test sections directly upon a prepared subgrade of soil or gravel. In this way the effect of the character of the sub-base on the behavior of the mixture may be determined. (The device constructed at the bureau is shown in Fig. 1.)

Another type of roller test of the same general design as that just referred to is the device used by H. F. Kriege of the France Stone Co., also described before the 1933 meeting of the paving technologists. The machine is a remodeled Dorry hardness-testing machine, carrying two rubber-tired wheels 8 in. in diameter and 1 in. in width. These wheels, suitably weighted, travel on a circular specimen 24 in. in diameter. The displacement of the surface by the rolling load is used as a measure of stability. With this equipment, specimens may be either molded in place as in the case of the larger test tracks, or they may be taken from the pavement after consolidation in the usual manner.

This machine is at present being used in connection with an experimental concrete-resurfacing project in Washington, D. C., in which trap rock, limestone and blast-furnace slag are being used as aggregates in both cold and hot bituminous-concrete mixtures. This investigation should be of great interest in correlating the results of the usual laboratory tests on these aggregates with the behavior of the mixtures in the roller-stability device and in the street. This work is under the direction of H. F. Clemmer, engineer of materials, District of Columbia.

Valuable as is the circular track, it is essentially large experimental laboratory equipment; is there no simple apparatus for testing aggregate quality?

► Accelerated service tests of the types just described, while extremely valuable in developing basic data, are obviously not suitable for use as acceptance tests. There remains then the problem of developing a simple, rapid and yet accurate laboratory test, the results of which may be correlated with service behavior, and which may be used to replace the present unsatisfactory standard test. This is no new problem. It has been recognized for years. However, due possibly to the inertia which so often delays any action involving a revision of standard practice, practically nothing had been accomplished toward its solution until quite recently.

In 1932 the committee on materials of the American Association of State Highway Officials decided to investigate a test that is in use on the West Coast known as the Los Angeles rattler test (*California Highways*, Vol. 3, No. 4, April, 1926). This test, developed a number of years ago in the laboratory of the city of Los Angeles, has been used by the California department of highways as a standard test for quality of aggregate since 1929. The method consists in running a 5-kg. sample of graded aggregate for 500 revolutions in a cylindrical drum 28 in. in diameter and 20 in. in length together with a charge consisting of twelve cast-iron shot of the same size and weight as the small shot used in the standard brick rattler. The inside of the drum is provided with a single shelf 4 in. wide extending from end to end. (The apparatus is shown by Fig. 2).

This test has many obvious advantages over the standard Deval test. It is much quicker. One test requires 15 min. instead of five hours. It is possible to test crushed rock or gravel of the size used in the work instead of requiring samples of quarry stone. The effects of impact are much more pronounced, with consequently a much wider spread between the values representing good and poor materials than is the case with the present standard. The indications are also that the results are independent of the shape of the aggregate particles, which would make it possible to apply the same specification requirements for gravel as for crushed stone.

The Bureau of Public Roads, working in cooperation with the committee on materials, has made a number of tests with the idea of checking the technique of this method as well as to accumulate data on materials, the service records of which are known. To this end, tests were made on the samples of aggregates examined by Goldbeck in his test track and discussed by him in the report just referred to. The results indicate a very close correlation with service behavior, which is more than can be said for the Deval abrasion test. Other tests have verified these observations, indicating that so far as can be seen at this time, the Los Angeles rattler test will prove an excellent substitute for the Deval abrasion test. It is expected that a report giving the results of these investigations will be available in *Public Roads* in the near future.

Another time-honored test for stone, which is viewed with some suspicion, is the standard test for toughness. It has been the practice for years to require stone that is to be used in the high-type mixed bituminous concretes or as a binder stone for sheet asphalt to pass a satisfactory toughness test. The values usually set range from 6 to 8. Due to the fact that many commercial sources of limestone are right on the border line, especially with regard to the upper limit, the true significance of this test becomes a matter of moment. Then, too, the test is made on such a small specimen that the results are frequently not representative. It is also an expensive test to make, requiring the use of a diamond drill in the laboratory.

The possibility that the Los Angeles rattler test may reveal the necessary information as to the ability of an aggregate to resist crushing under the roller leads to the hope that it may ultimately replace the toughness as well as the abrasion test. If so, it will be a distinct step in advance, not only because it will substitute one method for two, but also because it will then be possible to test all of the usual aggregates—that is, crushed stone, gravel and slag by the same method, greatly simplifying the writing of specification requirements.

With advances in determining aggregate stability, has inventiveness kept pace in more positive determination of stability of the aggregate-bitumen mixture?

► In the field of bituminous paving the rapidly changing character of traffic due to the advent of the automobile focused attention several years ago on the question of stability, and a number of tests were devised to measure this property of mixtures. (*Proc.*, fourth annual paving conference, Detroit, Mich., October, 1925). The best-known test of this type, that devised by Hubbard and Field, has been in use some time, and much information regarding the factors which affect stability has been obtained. This test is unquestionably of great value in investigating by means of a relatively simple laboratory test the factors that directly control stability. However, at the present time, less emphasis is being placed upon the importance of stability alone as a measure of service behavior. It has been shown that the most stable mix under this type of test is not necessarily the most durable in the long run. For instance, it is possible to design a mixture that will show high inherent stability but that will not contain sufficient binder to prove durable in service.

Investigations of bituminous mixtures seem to have followed about the same cycle as portland-cement concrete, where strength alone has long ceased to be considered a direct measure of durability. A realization of the fact that the original type of laboratory test for stability does not necessarily tell the whole story has brought about the most recent advance in the technique of testing bituminous mixtures, the circular test track already referred to. By means of such a device many factors affecting service behavior, including the effect of moisture, may be studied and evaluated.

Studies of the stability of sheet asphalt and bituminous concrete mixtures, in so far as it is affected by the aggregate, have been confined chiefly to investigations of the effect of grading and void content on mixture design. From the standpoint strictly of studies to determine the effect of such physical characteristics as surface texture, shape of particle, mineral composition, etc., very little has been done. The importance of making such studies, with the idea of explaining certain characteristics of paving mixtures due apparently to the aggregates, has been emphasized from time to time in papers before the Association of Asphalt Technologists and elsewhere, and the results of some exploratory investigations such as those of Nicholson (*Proc.*, Assoc. of Asphalt Technologists, Detroit, January, 1932) and Dow (*Proc.*, sixth annual paving conference, Atlanta, Ga., December, 1927) on fine aggregates have been reported. We have also the work of Miller and Troxler on mineral fillers (*Proc.*, Assoc. Asphalt Technologists, Detroit, Mich., January, 1932). However, so far as information that may be utilized practically in the preparation of specifications is concerned, the field is virtually untouched.

What is the situation in respect to mixed-in-place or road-mix surfacing mixtures?

▶ During the past ten years great progress has been made in the development of an intermediate type of road surface in which the aggregate and binder are mixed-in-place instead of premixed in a bituminous paving plant. This development has been along two distinct lines. In California and throughout the West generally a type of construction has been employed involving the use of a dense, well-graded crushed stone or gravel running from a maximum size of about 1 in. to and including dust. In the Middle West a type of construction known locally as "retread" is favored. In this construction an "open" graded or macadam type of aggregate is used.

In so far as the graded aggregate type is concerned, research activity has centered largely in California, where studies of the effect of aggregate characteristics on stability have been in progress for some time. In a paper before the 1932 Asphalt Paving Conference (*Proc.*, Asphalt Paving Conference, New Orleans, December, 1932), C. S. Pope discussed a number of the tests that have been developed in connection with this work. These include tests for mechanical stability, a moisture test for the purpose of determining the resistance of the mix to disintegration in wet weather and a water-asphalt preferential test for the purpose of determining whether the filler material has a greater affinity for water than for the oil. For the purpose of determining the correct percentage of oil to add, several formulas based on the percentage of the various-size particles in the aggregate

FIG. 2—RATTLER TEST apparatus which promises advantages over the standard hardness and toughness tests for aggregates.

have been developed. These are all modifications of the original formula introduced by McKesson and Frickstad in 1927 (*Public Roads*, September, 1927).

Of interest from the standpoint of the utilization of aggregates in this type of construction is the fact that more attention is being paid to gradation. No longer is the engineer content to use any available material. He insists now on obtaining a proper balance of sizes to make a well-graded mix even if processing is required to accomplish this. Present practice in two widely separated states, North Dakoha and Vermont, is described in recently published articles to which the reader is referred (*Public Works*, April, 1934, for North Dakota practice; and *Engineering News-Record*, Oct. 18, 1934, for Vermont practice).

On account of the inherent stability of crushed aggregate, this type is still favored in constructing low-cost bituminous roads. Gravel is frequently used, but a certain percentage of crushed particles, usually not less than 40 per cent, is ordinarily required in order to provide the essential mechanical stability. Research is needed to determine more definitely the relation between the angularity of the individual aggregate particle and the stability of the mixture. For a general discussion of the use of gravel in the various types of road surfaces, the reader is referred to a paper by B. E. Gray of the Asphalt Institute presented at the sixteenth annual meeting of the National Sand and Gravel Association. (*National Sand and Gravel Bulletin*. April, 1932).

Has the study of durability been equally stressed in the development of aggregates for concrete?

▶ In so far as the use of aggregates in portland cement concrete is concerned, recent interest from the research standpoint has centered largely in studies of the effect of quality of aggregates on durability. The premature failure of certain pavements and other concrete structures in western New York and Pennsylvania, as well as in other sections of the country subject to severe weathering, has served to call attention to the necessity of thoroughly investigating this most essential property. Studies so far seem to have established the fact that the quality of the aggregates plays an important part in controlling the resistance to weathering agencies. The work of a number of investigators all leads to this conclusion, as including for instance Gonnerman and Ward of the Portland Cement Association (*National Sand and Gravel Bulletin*, May, 1931); C. H. Scholer, Kansas State College (*Proc.*, Highway Research Board, tenth annual meeting, December, 1930); Lang and Hughes, of the University of Minnesota (*Proc.*, A.S.T.M., 1931, Part II); and L. O. Hanson, of the University of Wisconsin (*Proc.*, Highway Research Board, thirteenth annual meeting, December, 1933).

The importance of using aggregates of unquestioned soundness has been demonstrated, although Gonnerman and Ward (*National Sand and Gravel Bulletin*, May, 1931, p. 20) have shown that the danger of using aggregates of somewhat doubtful quality may be lessened by employing a cement paste of very high quality (low water-cement ratio). It has been shown further that the conventional tests for quality, such as the Deval abrasion test for coarse aggregate (crushed stone, gravel and slag) and the strength ratio test for sand do not necessarily answer the question so far as durability is concerned, but that special tests for soundness must be used (*Proc.*, Highway Research Board, twelfth annual meeting, 1932, p. 329).

What methods have been devised for determining soundness within time limits practicable for use in construction?

▶ The most widely used accelerated laboratory tests for soundness are based on the destructive force produced by the crystallization of mineral salts, such as sodium sulphate and magnesium sulphate within the pores of the aggregate, resistance to such action being assumed to be a measure of durability. A large amount of work on these tests has been conducted by various research agencies, including several state highway departments, universities and the Portland Cement Association. A report by Verne McCown (*Proc.*, Highway Research Board, eleventh annual meeting, 1932), published as a part of the report of the committee on correlation of research in mineral aggregates, summarized these activities up to 1931 and presented certain conclusions that seemed warranted at that time.

The available data did not seem to justify any positive conclusions regarding the significance of the accelerated

sodium-sulphate soundness test. Reports were somewhat contradictory both regarding the severity of the test and its correlation with service behavior or freezing and thawing tests. Due to variation in the solubility of sodium sulphate within the temperature range usually encountered in the laboratory, as well as the fact that the salt may assume more than one crystal form within this range, attempts have been made to develop a method using magnesium sulphate, a salt which is free from these defects. The New York Department of Public Works has done a large amount of work with this test. Ira Paul (*Proc.*, Highway Research Board, 1932) shows a considerably better correlation between the magnesium test and service behavior than when sodium sulphate is used. As the result of his investigation he recommends a maximum percentage of loss for fine aggregate of 17 per cent when tested with magnesium sulphate. The fact that the magnesium-sulphate test is free from a number of variables found in the sodium-sulphate method is a distinct advantage in favor of its use. However, aside from the work in New York there are practically no data available as yet regarding the significance of the results. Until such information, covering a wide range of conditions and materials throughout the country, is obtained it will be impossible to use this as an acceptance test for general application. Investigations developing this information are badly needed.

What effect have the aggregates had on strength and volume change of concrete?

► A significant development in the design of concrete mixtures for pavements is the recognition that is being given to the fact that the character of the aggregate does affect the strength of the concrete, particularly in flexure and tension. A number of state highway departments are now designing mixtures on the basis of flexural strength. The influence of the type of coarse aggregate on the strength of concrete was revealed in a series of tests conducted by the Bureau of Public Roads several years ago (*Public Roads*, June, 1929). It was shown that variations in flexural strength equal to that caused by a change in the water-cement ratio of 0.2 may be caused by changing the character of the coarse aggregate. Other investigators have also noted the influence of aggregate characteristics on the strength of concrete (R. Grun, *Die Betonstrasse*, No. 4, April, 1934). A method of design which takes this factor into consideration has been advocated by the bureau (*National Sand and Gravel Bulletin*, May, 1932; *Public Roads*, August, 1928). This method has been used by the Wisconsin highway department for several years in all of its concrete work and has proved entirely feasible from a practical point of view. Other methods of design which likewise recognize the importance of considering the aggregate have been adopted in a number of states, including Illinois, Tennessee, Michigan and Texas. The practice in Texas should be of great interest to concrete technicians due to the remarkable results in the way of strength that are being secured (*Journal*, American Concrete Institute, November-December, 1933, p. 5).

Volume changes in concrete may be caused either by the application of loads or by variation in temperature or moisture content. Practically all investigators are agreed that the character of the coarse aggregate influences to a marked degree the change in volume due to each of these causes. P. M. Noble (*Proc.*, A.S.T.M., 1931, Part I) has found for concrete of approximately equal strength and age a variation of about 100 per cent in the modulus of elasticity, due to this factor alone. His aggregates varied from a rather soft limestone showing a low modulus to chert gravel having a modulus almost twice as high. He concludes that those results are "particularly significant, the extent of the variation being such that it should by all means enter into the design of reinforced-concrete structures."

R. E. Davis, of the University of California, has done a great deal of work on volume changes due to variations in temperature and moisture. He finds that the character of the aggregate quite overshadows the effects of most of the other variables studied (*Proc.*, A.S.T.M. 1930, Part I). He found values for the thermal coefficient of expansion ranging from 0.0000038 in. per degree F. for limestone to 0.0000066 in. for quartz. The contraction of concrete on drying out and its expansion on wetting is also greatly affected by aggregate type, according to Davis, the percentage of contraction in three months ranging from 0.036 per cent for quartz to 0.075 per cent for sandstone and 0.079 per cent for the particular type of gravel used in the test.

In connection with this same matter, the tests reported by Bert Myers of the Iowa State Highway Commission are of interest. (*Proc.*, Highway Research Board, eleventh annual meeting, 1931). Certain measurements on field specimens showed a wide range in "the apparent thermal coefficient of expansion" due to the coarse aggregate. For a temperature range of 54 deg. F. the value for limestone was approximately 0.0000035 in. per degree F. as compared to 0.0000056 in. for gravel.

The above results are cited to show the wide variation in elastic properties and volume change which may be caused by differences in the character of the coarse aggregate. Just what particular properties of the aggregate cause these effects is not known. Research to throw light on these fundamental relationships is greatly needed.

As an illustration of the effect of character of aggregate on the tendency of a pavement to develop transverse contraction cracks, reference may be made to the twenty-year-old pavement described some time ago by the writer (*ENR*, Sept. 28, 1933). Here, although the strength of the concrete containing two distinct types of aggregate was practically the same, a marked difference in the amount of cracking was noted. Just what has caused this very appreciable difference in behavior is somewhat of a mystery.

Has our knowledge of light-weight aggregate, crushed-stone sand and of the effective use of low-grade stone increased?

► A large number of data bearing on the effect of various kinds of deleterious materials in concrete aggregates has been accumulated during the past few years. The problem of securing aggregates reasonably free from such materials as shale, soft or weathered fragments and the like is of extreme importance when selecting material for pavements or other structures subjected to weathering. Furthermore, the nature of available sources of supply in certain states is such that very rigid inspection is necessary to insure satisfactory materials. As so often is the case when freedom of choice is restricted because of high costs of importing material from a distance, the tendency has been to draw specifications so as to utilize the best material available within a given area. Research has naturally been most active in such localities. An excellent review of recently completed tests made by the state highway departments of Minnesota, Michigan, North Dakota, Tennessee and Kentucky, the National Crushed Stone Association, and the National Sand and Gravel Association has been prepared by Walker and Proudley (*Proc.*, Highway Research Board, twelfth annual meeting, 1932).

This summary forms part of the report of the committee on correlation of research in mineral aggregates for that year. In the same report there appears also a paper by A. T. Goldbeck discussing the nature and effects of surface coating on coarse aggregates. These two reports, which contain the results of the latest available information on the subject of deleterious substances, state that the data are not sufficiently extensive or conclusive to warrant the preparation of definite numerical requirements for more than local application.

The manufacture and use of prepared stone sand as fine aggregate have increased very materially with recent years. Many limestone plants, particularly in the Middle West, are now equipped to manufacture products that will meet very exacting grading requirements. Provided the stone used in the manufacture of the sand is of unquestioned soundness, there appears no reason why suitably graded material should not make entirely acceptable fine aggregate. The matter of grading is impor-

tant, of course, due to the usual tendency of sandstone to produce a somewhat harsher working concrete than natural sand. Devices for processing have been developed to the extent that it is now possible to produce uniformly graded material complying to almost any required gradation. Experience has shown that, with this factor controlled, very satisfactory concrete from the standpoint of workability can be secured. A survey of the extent to which stone sand is being used in connection with concrete was presented at the fifteenth annual meeting of the National Crushed Stone Association (*National Crushed Stone Journal*, May-June 1932). The same issue of the *Journal* reports the results of a series of laboratory tests by A. T. Goldbeck, to determine the most satisfactory grading for manufactured stone sand.

Light-weight concrete has been made from a variety of materials ranging from cinders to materials manufactured especially for the purpose, such as Haydite. This characteristic is of importance in highway work in connection with the design of long-span bridge decks with the idea of decreasing the dead load. In order to develop information as to the strength and other properties of concrete made with Haydite concrete as compared to similar concrete using gravel and limestone, the Bureau of Public Roads, in cooperation with the Port of New York Authority, conducted an extended series of tests on full-size specimens. The results of these investigations were published in 1931 (*Public Roads*, December, 1931) about the same time as the results of an extensive investigation carried out by F. E. Richart and V. P. Jenson, of the University of Illinois (*University of Illinois Bulletin 237*, October, 1931). Both of these investigations show that the crushing strength of Haydite concrete for comparable water-cement ratios is about the same as concrete containing the normal aggregates. However, both investigations indicated that the Haydite concrete developed only about one-half the modulus of elasticity of comparable mixes containing the usual types of aggregate. In flexure the tests by the Bureau of Public Roads indicated a continuing retrogression in strength for the Haydite concrete from ages of three months to one year. The cause of this rather unusual behavior was not determined at the time, and a supplementary series of tests has been undertaken with the idea of throwing additional light on the subject. The results of these tests will be available shortly.

Concrete Floor and Timber Sides Used for Flume in Colorado

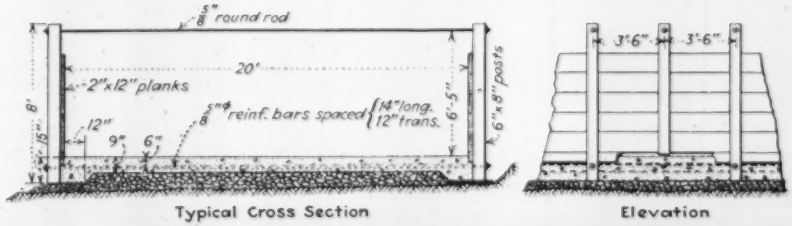
AN UNUSUAL TYPE of flume construction with concrete floor and timber sides has recently been used to replace a section of all-timber bench flume on the High Line Canal, which diverts water from the South Platte River, 21 miles south of Denver, to irrigate a district south and east of the city. At the mouth of Platte Canyon, about 3,000 ft. of timber flume is used to negotiate the rugged slopes; the foundation is benched out of the steep rocky canyon. Considerable difficulty has been experienced in the past with falling rock and earth slides above the flume. The material lodges in the flume and frequently breaks down the up-hill side. For convenience in removing the material, the workmen frequently dismantled the side of the flume adjacent to the river. Further, there was the usual difficulty in inspecting and repairing the sills and floor. To meet these conditions, the new flume, with a concrete floor, was constructed.

A reinforced-concrete slab was laid down to form the floor of the flume, as shown. It rests on a gravel blanket and is built without expansion joints. Drain pipes required to take care of seepage from the canyon sides are installed in this gravel blanket. The timber side walls are bolted to the concrete floor; to facilitate renewing the bolts, 1½-in. pipe is cast in the floor through which tierods pass, bolting the posts to the sides of the floor. These tierods are made out of used pump rods. Planking is spiked to the posts to complete the flume sides. A temporary road was built on the embankment, paralleling the flume, over which concrete was brought in from a central mixing plant located a mile away at the mouth of the canyon.

As a preliminary experiment, a section 727 ft. long was rebuilt with this type of construction several years ago. As it proved satisfactory, an additional 1,770 ft. was rebuilt last fall.

The combination flume was designed by D. D. Gross, chief engineer of the Denver Board of Water Commissioners, which owns all of the stock of the Northern Colorado Irrigation Co., owner of the High Line Canal. August P. Gumlick, president of the irrigation company, is also president of the Denver Board of Water Commissioners. H. R. Oliver was the water board engineer in charge of the construction, which was contracted by Frank Kenney.

FLUME SECTION with concrete floor, showing method of attaching timber sides.



FLUME IN PLATTE CANYON, subject to rock slides, being rebuilt with concrete floor and timber sides.

Details of Design that Influence Steel Bridge Economy

Suggestions and elementary facts derived from a study of fabricating-shop practice and costs

By Albert F. Jordan
Bethlehem, Pa.

IN THE DESIGN of steel bridges the details have a marked influence on the initial cost, and they may also affect the cost of maintenance to some extent. There are two fundamental rules for economical design which may be considered basic. These are: (1) that simplicity of construction tends toward economical construction; and (2) that the cost of fabrication decreases with the increase in duplication. By simplicity of construction is understood the absence of many small members, the absence of work requiring exactness that is beyond the ordinary scope of structural machines, and the use of such construction as would tend to keep all work moving through its various stages in the shop at a uniform rate and to assist in ease of erection.

Duplication reduces the cost because of the saving incurred where shop drawings, patterns, templets and machine set-ups can be used repeatedly without modification. Also, when a man repeats the same operation again and again, he becomes more efficient. The effect of similarity of work is also to reduce cost, though of course not to the extent of the exact duplication of work.

Truss bridges

Main Members—In truss bridges the number of main-truss members should be as few as possible. This will tend to make the members long and heavy, and in that way concentrate the material and work. It will furnish a minimum number of pieces to handle both in the shop and in the field. It will also reduce to a minimum the number of gusset plates to install, of holes to punch and of rivets to drive. The holes and rivets will also be in a minimum number of scattered groups.

When members are heavy, their sections are built up of thick plates or of combinations of thinner ones. It is evident that the cost for punching or drilling holes does not increase in proportion to the increase in thickness of the metal; also, that the cost for driving shop rivets through thick material is very little greater than for driving them through thin material. The making of shop working drawings and templets and the performing of many of the shop operations are not greatly affected by increasing the thickness of material used.

Panel Lengths—In any one truss equal panel lengths should be used, thus making the floor beams alike and the stringers alike. It is sometimes possible (if the pier locations may be shifted slightly) to use the same panel length for all truss spans in a bridge, even though there may be various lengths of span. This is not a very common practice, but the economy in the floor system is worth consideration.

Where a number of spans are required in a bridge, the economy effected by making the spans exact duplicates is obvious. Duplication of all truss members and floor members would follow, and the saving in shop fabrication would be reflected in bidding on this class of work.

Parallel and Curved Chords—The fabrication cost for truss spans with parallel chords is less than for spans with curved or camel-back top chords. Experience has shown that no saving in weight of material results from using curved-top chords instead of parallel chords, where the span length is 150 ft. or less.

Where a curved chord is used, the chord sections should run straight for as many panels as possible. Each change in the slope of the chord necessitates a chord splice, and unnecessary splices should be avoided because they mean additional pieces to handle both in the shop and in the field. Also each splice must not only be milled but milled to an angle. The curved-chord truss also requires more variation in the top-chord bracing and the sway-bracing than is necessary for the parallel-chord truss. On the curved-top chord, also, bent-plate connections must be used for the lateral bracing.

Closed Members—There has always been considerable opposition to the use of boxed members in steel construction because of the difficulty of maintenance. The cost of fabrication should also be considered. When a member is completely closed there are some parts that cannot be fitted up or riveted unless a man crawls inside the member, to insert the fitting-up bolts and the rivets. Also the rivets must be held in cramped quarters on the inside of the member, for driving. These rivets are driven with hand-held pneumatic hammers, which do not produce as satisfactory work as the heavy horse-shoe riveters used on open members where there is enough room to use them. The small hand-held riveter does not do the work as expediently as the horse-shoe riveter. An estimate of fabrication cost of a closed bridge chord showed the cost of fabrication to be 10 per cent higher due to having the boxed section.

Esthetic Details—Beauty has its place in structural design. Curves such as are sometimes used on gusset plates are pleasing to the eye, but they increase the fabrication cost. Straight cuts are made by a single stroke of the plate shear. The curved cuts are made with burning tools, or with narrow plate shears which make repeated short cuts along the outline of the curve. In either case trimming with a chisel or grinding wheel or both is generally necessary.

The curved-top chord is used on trusses in many cases, chiefly because of its appearance. Its cost, as stated above, is greater than for a straight chord.

The engineer must determine to what extent he can or should sacrifice economy for appearance.

H-Sections—Where H-section members can be used for diagonal and vertical members and for bottom chords, the fabrication cost of the trusses will be about 15 per cent less than if built-up plate-and-angle sections are used. Maintenance of H-section bridge members is also easier and less costly than for built-up members.

The use of rolled I-sections in bridge floors has become almost standard practice. The setting of stringers on top of the transverse floor beams instead of framing them in is a question often debated. Framing stringers into the webs of floor beams must be very accurately done so as not to force or twist the beams out of position. Many specifications require stringer ends with their connections to be milled to a true surface, or made up in a box, so there is the assurance that the connections are true. It is often specified that connection holes be sub-punched and reamed to a metal templet. By setting the stringers on the floor beams there is no danger of twisting the beam or forcing it out of its true line, and the exacting specifications do not apply. This means a saving in shop cost. It may however be necessary to use diaphragms between the stringers for stability and, if this is done, the stringers can be riveted up in pairs with the diaphragms in the shop. This will greatly facilitate erection. The setting of stringers on top of floor beams is more satisfactory in highway bridges than in railroad bridges, because of the smaller floor-load concentrations on the former. By placing stringers on top of floor beams it may be practicable to make the stringers in lengths of two panels, which reduces the number of individual pieces to handle.

Girder bridges

Curved Flanges—In girder-bridge design as well as truss-bridge design, details making for economy of fabrication must be considered. Uneconomic features occasionally appear, such as making the flanges of a girder conform

to an arc of a circle. This, perhaps, is done where a bridge is near the top of a hill, and the top flanges of the girders are made to the vertical curve of the road. It is done more often where plate-and-angle girders are used as transverse floor beams and have the top flanges curved to the roadway crown. The so-called fish-belly girder belongs to the same class as the above two illustrations. In this girder the depth at the center of the span is greater than at the ends. This results either from sloping the bottom flange from a point near the center of the span toward the end of the girder, so as to give the bottom flange a smooth curve, or from making a sudden change in the depth of the girder near its end. This type of design costs more to fabricate than the standard parallel straight-flange design, because of the following extra operations:

1. The girder web plate must be sheared or burned to the irregular shape desired.

2. The flange angles and coverplates must be bent to the shape of the edge of the web plates.

3. The stiffener angles must be of varying lengths to suit the varying depths of the girder, and these stiffeners must be machined to various angles on their ends, to conform to the slopes of the flanges instead of only machining them square and of constant length.

It is practically impossible to give an average cost figure indicating the extra cost of this type of work, as each design is a separate study by itself. But in extreme cases the increase in cost may be as high as 100 per cent.

Girders on Grade—Engineers often require the stiffener angles on the webs of girders placed on grade, as in ramps, to be vertical. This is more expensive than having the stiffeners normal to the girder flanges because the holes through the web plates must be punched individually instead of being arranged in a group. Also it costs more to machine the ends of stiffeners to an angle than to machine them square for bearing against the flange angles.

Stiffeners and Covers—In the design of girders, the omission of interior stiffener angles is sometimes feasible. Also the omission of flange coverplates is sometimes worth considering. The portion of the total cost of fabricating a girder, which the use of flange coverplates and web stiffener angles causes, is dependent upon the number of stiffeners, the depth of the girder, the length of the girder, the number of coverplates, and other factors. For the average girder design these two details each are responsible for about 25 per cent of the fabrication cost.

Modernizing the Pump House for an Underpass

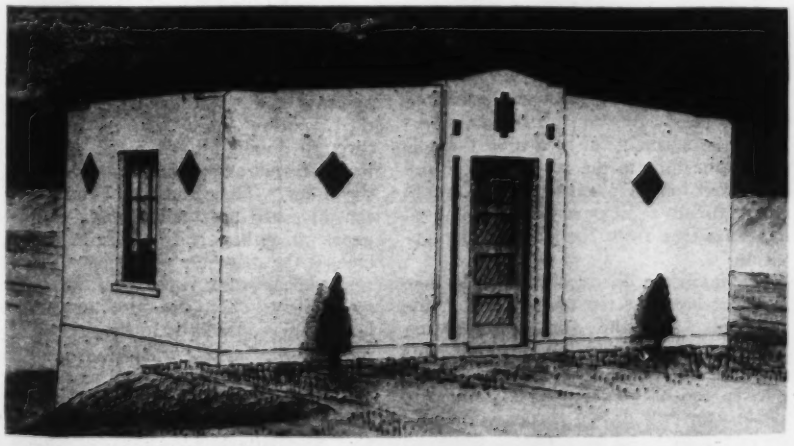
By R. B. McKnight
Mississippi State Highway Department, Jackson, Miss.

IN KEEPING with the tendency toward improvement in landscaping both new and old highway building projects, C. S. Hill, bridge engineer, Mississippi state highway department, is definitely inclined toward the use of adequate care and thought in the exterior design of structures. The accompanying illustration shows a perspective drawing of a pump house soon to be constructed at Amory, Miss. This work, a small part of the entire project, is a fair example of the application of this visual improvement attitude to a definite situation.

The structure shown consists of an underground reinforced-concrete pit, 11 ft. wide and 2 ft. long (inside), with a depth of 21 ft. from the steel grating floor to the pit bottom. A construction joint occurs about 8 in. above the machinery-floor level. The walls and roof of the house are of reinforced concrete, with an applied roofing consisting of three-ply, 15-lb., asphalt-saturated felt and four moppings of hot asphalt, laid alternately. The slab is first treated with a priming coat.

The flashing at roof parapets is of 14-oz. soft copper, and at roof hatch curbs (with steel covers) is 24-gage galvanized iron. Scupper, downspout, downspout head and straps are of 14-oz. hard copper, and are located on the rear wall of the building. A steel ladder to the roof is located on the end of the building opposite the window. The window consists of a steel sash in a 3-ft. 2-in.x4-ft. 8-in. opening. The door is wood, of heavy built-up type. This house varies from the conventional in that a 3-in. projection of the central door feature is provided, and the parapet is varied in height to conform to a simple inexpensive scheme of exterior design. Also, insert designs are provided for, consisting of 3x6-in. plain quarry tile of varying shades.

The cost of these items is a very few dollars, and it is believed that the slight additional expense will be compensated for by the fact that the house, when seen from the roadway or from passing trains, will be recognized and appreciated as something more than an unpleasant interruption in an otherwise attractive view.



PUMP HOUSE for draining a highway underpass designed to be a roadside attraction without greatly increasing the cost.

Waitaki Dam in New Zealand for Large Power Development

The Waitaki Dam, which is the principal feature of New Zealand's largest hydro-electric power development, has just been completed after a six-year construction period at a cost of $13,000,000. The dam is located on the Waitaki River about 45 miles from Oamaru, South Island. Of gravity type, the dam has a maximum height of 120 ft. and an over-all length of 1,730 ft., including a 350-ft. section of power house and a spillway 1,160 ft. long. Reservoir storage is not an essential feature of the project, as the normal flow of the river is sufficient to operate the five generating units that will ultimately develop 100,000 hp. This power plant will constitute the principal generating station in the southern part of the Dominion.

Large Steel Main Cleaned Under Water

New equipment and new technique developed to remove tubercles from paper company's submerged intake line—Problem complicated by vertical bends at both ends of line

By Arthur T. Clark
Consulting Engineer, Troy, N. Y.

THE successful cleaning of steel or cast-iron water mains as used in ordinary waterworks systems is a daily procedure. The successful cleaning of 2,000 ft. of 48-in. steel main submerged under 30 ft. of water, however, as was recently accomplished for the Hammermill Paper Co. at its Erie, Pa., plant, presented a host of new problems. To overcome the difficulties involved in the unusual job, customary pipe-cleaning equipment and technique both had to be modified.

The pipe that was cleaned is an intake line supplying process water to the plant. It was laid in 1911 and is composed of ⅜-in. steel with lap joints, riveted with large round-head rivets in longitudinal and transverse joints. The flanged pipe units are 40 ft. long, each built up of five lap-riveted and assembled sections to facilitate installation. The lake end is under 30 ft. of water, and the inlet is through a 48-in. vertical tee with a plain bell mouth. A 25-ft.-square timber crib with heavy stone backing protects the pipe opening.

The shore end of the intake pipe discharges into a pump well under gravity flow through an enlarged 90-deg. elbow, with drop pipe extending to within a few feet of the well bottom.

Normal mill demands require water at rates of 20 to 30 m.g.d. After 23 years of accumulated tuberculation the capacity of this 48-in. intake had been reduced to a maximum rate of 23 m.g.d. under safe pump-operating conditions—that is, with a safe drawdown in the pump well.

A section was cut from the intake pipe to facilitate inspection and to provide a test section to determine the exact nature and amount of tuberculation and corrosion. The tuberculated material removed from this test section, together with a general inspection of the pipe at several inspection manholes, indicated the following:

(a) The tuberculation was general and uniform throughout the entire inner surface, being about ⅝ in. thick, with prominences up to 2 in. in height and 3 in. in diameter.

(b) In general, the tuberculation was comparatively soft, not having the hard calcium and somewhat impervious shell encountered in pipes carrying a treated domestic supply.

(c) The 703-sq.in. inner surface of the test section yielded 1.8 lb. of tuberculation, measuring 61 cu.in. Bone dry, this material weighed 51.8 lb. per cu.ft., and after one-half hour's submersion weighed 78.1 lb. per cu.ft.

(d) These figures, applied to the entire 1,931 ft. of the pipe line, indicated a volume of about 200 cu.ft., or 8 tons of tuberculated material.

(e) Careful examination of the test section revealed no indication of corrosion of the steel plate. The pipe was fabricated from open-hearth steel and was coated with asphaltum when laid.

Seasonal flows, also, probably produce a variation in these figures.

Cleaning

The cleaning of the line presented several interesting operating and mechanical problems which had to be met.

1. The cleaning machine had to be inserted into a 48-in. vertical tee at the lake end of the pipe and then worked into a horizontal position, under 30 ft. of water. A machine for this diameter pipe had to be at least 5 to 6 ft. in length, and had to be sufficiently collapsible to negotiate the quarter-turn in the tee. It also had to be capable of expansion after being placed in the pipe to produce the necessary blade pressure on the inner surface of the pipe for thorough cleaning.

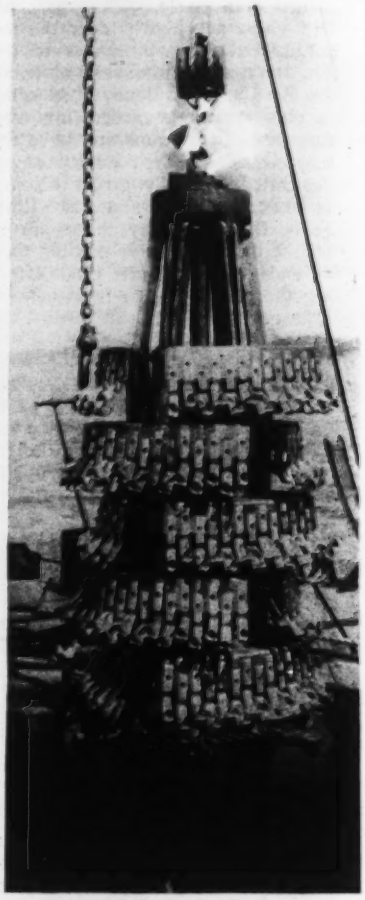
2. The machine had to be returned to and removed from the tee in the lake crib, as the enlarged 90-deg. elbow and the length of the down pipe prohibited removal from the shore end.

3. The machine had to be capable of being collapsed or expanded from both ends.

4. It had to be sufficiently rugged to withstand a cable pull that was estimated at four tons.

5. The necessity of returning the collapsed machine to the lake crib required the provision of a carriage that would automatically support the collapsed machine free from the pipe in any position.

To facilitate operations, a cable hole was cut near the top of the bend in the pipe pit, and the various operating cables were either fed through this opening or pulled through it over a sheave to the power winch. A ⅜-in. cable was first drawn through the pipe from the lake end by a double umbrella float. A ¾-in. cable was then drawn into the pipe from the shore to the lake crib and was followed by a ¾-in. cable, used to pull the cleaning machine. Before passing the float through the intake pipe it was weighted for buoyancy and, under a static head of 2½ ft., easily drew the ⅜-in. cable from the crib to the pump pit.



CLEANING MACHINE, collapsed and nose up, ready to be lowered into the intake tee.

The assembled machine has a minimum diameter of 30 in. collapsed, and a maximum diameter of 49½ in. when fully expanded. There are 210 spring-steel blades, comprising fifteen segments, located alternately at quarter-points. The segments are mounted on a series of longitudinal tee iron frames, the position of which is controlled through double-hinged arms, connected to the frame at one end and to a nut at the other. The rotating of a threaded central shaft, operated through enclosed gears at either end, increases or decreases the diameter of the machine. A removable crank operates the entire mechanism. By the use of double-hoist lines attached to each end the cleaner was easily warped around the 90-deg. angle in the tee and worked into the extension of the 48-in. intake on the lake side of the tee. The 34-in. cable was then attached to the draw eye in the head, and the machine was drawn

forward on its carriage into the intake pipe in its collapsed position. The cleaner was then expanded to a diameter of 49 in., producing a compression of ½ in., in the cleaning blades around the circumference, this compression producing a pressure on the pipe of about 30 lb. in each blade, or a total friction weight of roundly 6,300 lb. for the machine.

To relieve the cleaning machine of the weight of the ¾-in. cable, when under tension, a wooden float, 3 ft. in diameter and 1 ft. thick, was threaded onto the cable and clamped about 25 ft. ahead of the cleaner. This float also acted as a plunger under flow. The cleaner was drawn through the pipe at a rate of about 6 ft. per minute.

The pump capacity available during the cleaning operation was limited to the volume that could be wasted from the settling basins while the mill was shut down. With this rate of 12 m.g.d., or a velocity of 1.48 ft. per second, it was feared that a considerable amount of loose tuberculation might be left in the invert of the pipe. An inspection of the pipe at two manholes midway between the intake crib and the shore immediately after cleaning revealed a very clean pipe with practically no loose material remaining on the bottom. The cleaner was then collapsed in the pipe at the shore end, redrawn to the lake crib on its carriage by the ⅝-in. return cable and removed.

Results

Before cleaning, the loss of head was carefully observed for various rates of flow, indicating a value of C (Williams and Hazen) of 57, and the maximum rate of flow under a permissible loss of head to the pumps was 25 m.g.d. After cleaning, the value of C was 87, and there was an indicated maximum flow of 35 m.g.d. and up, under permissible operating conditions.

All under-water work, including the entering, expanding and removal of the cleaning machine, was done by divers under the supervision of David Hill, superintendent for the Merritt-Chapman & Scott Corp., who had the general contract with the Hammermill Paper Co. for the cleaning and repairs of the intake. Local plant supervision was under the direction of K. H. Fleming, of the engineering department of the Hammermill Paper Co. The cleaning operation was under the supervision of Joseph B. Conners, superintendent for the National Water Main Cleaning Co.

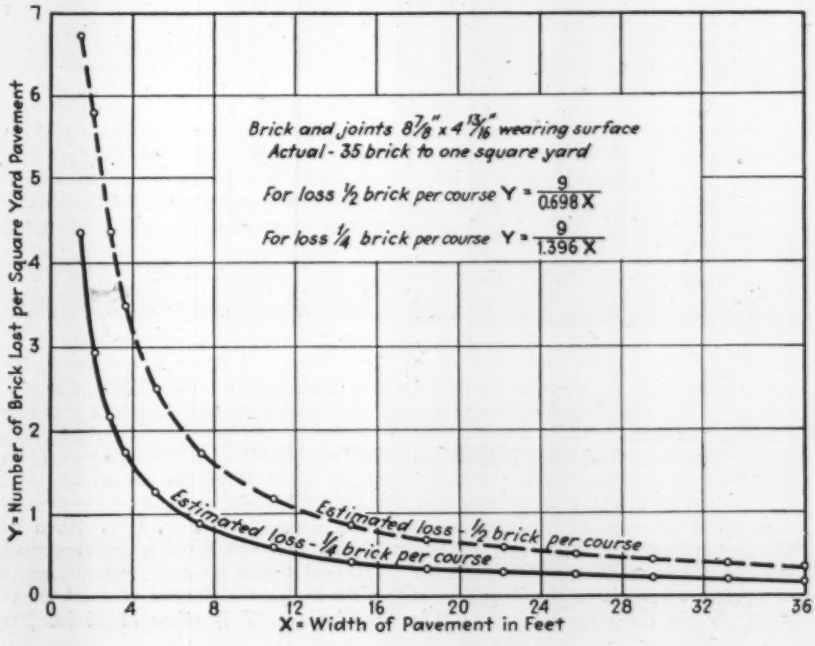
Allowance for Cuts and Bats in Laying Brick Paving

By Charles Wuest, Jr.
Consulting Engineer, Peebles Paving Brick Co., Portsmouth, Ohio

RECENT EXPERIENCES in connection with brick-pavement widening operations have convinced the writer of the need of more consideration of the losses of material sustained due to cutting bricks to make closures. So far as can be determined, the exact volume of this wastage is not generally known even approximately, and cost allowances have long been subjects of contention between engineers, contractors and manufacturers. The accompanying curves undertake to establish this wastage on a quantitative basis.

The curves show the number of bricks lost per square yard of paving as a result of cutting for closures in pavement widths of 1½ to 36 ft. Two loss curves are shown. The upper is based on the loss of ½ brick per course, while the lower is based on the loss of ¼ brick per course. Of these the lower curve more nearly approaches actual field conditions than the upper, and is therefore recommended for use in estimating losses sustained due to cutting for closures.

LOSS OF BRICK per square yard of pavement resulting from cutting brick for closure in pavement widenings of 1½ to 12 ft.



The application of the lower curve to a recent contract showed a remarkably close check on brick losses sustained due to cutting on a widening job. On this contract there were about 7,000 ft. of 2-ft. widening (1,556 sq.yd.), and about 4,500 ft. of 4-ft. widening (2,000 sq.yd.); a brick shortage of 8,000 brick was claimed by the contractor. Had this contractor known before he bid the job what his probable losses would be, due to cutting for closures, he could have fully protected himself against the loss sustained, which amounted to about $700 for material and labor. Using this job as an example, the graph shows that the contractor sustained a loss of 3½ bricks per square yard on the 2-ft. width and 1½ bricks per square yard on the 4-ft. width due to cutting.

The curves clearly indicate that the losses increase most notably between the 12-ft. and 2-ft. widths. They indicate also the economy in widening on one side rather than both sides when that is practicable. As an example, the loss of brick sustained in a 4-ft. widening is approximately 46 per cent of the loss sustained in a 2-ft. widening. As pavement widths increase, the loss of material due to cutting is materially decreased.

It is evident that in estimating work of this character, engineers should increase their estimates of cost, to provide for such losses of material and labor as are necessarily incurred. These cost increases will vary from 10 to 20 per cent above the cost of the same type of work for standard-width pavements.

Letters to the Editor

Marine-Borer Activity

Sir—A misleading statement appears in the final sentence of your editorial entitled "Marine Borers Again Active" in the Jan. 31 issue wherein you say reduced sewage pollution "results in exposing marine structures to attack by marine borers." The writer cannot let this statement go unchallenged because he considers it important that the facts about the marine-borer menace become widely known.

Ordinary sewage pollution does not prevent marine-borer attacks; in a number of places these pests have destroyed the timbers in wood box sewers. However, the discharge from sewers containing the effluent from gas plants, chemical works, etc., does afford a measure of protection so long as the toxic material is present in the waters. An example is on record in which untreated piles, immune for many years because of the protection afforded by a toxic effluent from a gas plant, were attacked immediately when the discharge of this effluent was discontinued.

Numerous instances similar to the foregoing and supporting the same conclusions are given in the report of the San Francisco Bay Marine Piling Committee, published in 1927 after studies extending over an eight-year period.

Activity of the *xylotria* (or *bankia*) and *limnoria* will be retarded by the discharge from sewers in so far as the sewage lowers the average salt content of waters surrounding the wood structures. However, the arrival of the *teredo navalis* along our waterfronts (probably in the bottoms of wooden vessels pressed into service in Europe in the early days of the World War) put an entirely new angle on the problem because this borer will remain active until salinity decreases to five parts per thousand, i.e., a slightly brackish water.

Practices that were safe in the design of waterfront structures prior to the arrival of *teredo navalis* no longer can be used. For example, the Starr Flour Mill, constructed in 1882 on an arm of San Fransico Bay where salinity is low by reason of fresh water inflowing from the Sacramento and San Joaquin Rivers, was supported upon green piling and remained immune to attack of borers of any kind until 1917. Then in a very short time highly destructive effect was caused by *teredo navalis* exclusively.

The publication of reports of rapid destruction of untreated piles along the New England coast bear a striking resemblance to the record of conditions encountered in San Francisco Bay from 1917 to 1920. Apparently this pest, which has become so well known on the West Coast, is spreading into new waters. Engineers responsible for marine structures in such localities should profit by experience gained where the *teredo* has become well known.

Teredo navalis, known in Holland for several hundred years, differs from marine borers native to our waters in several particulars. One of these is that the spawn of the *teredo* has a paddle, can keep afloat for 30 days or more, and thus aids itself to find lodgment. The spawn of other borer species have no such means of propulsion and are carried back and forth by the tide until they settle to the bottom. Thus the percentage of survival of *teredo* spawn is many times greater than that of other species. During the breeding season the *teredo* reproduces rapidly; the spawn matures and produces a second generation in about six weeks.

A very high percentage of the damage caused by marine borers is preventable, requiring only the application of well-known principles of biology to the use of engineering materials and design. In waters that contain as much as four to five parts of salt per thousand for a considerable part of even one year it seems to the writer that an inflexible rule should be to require that only pressure-creosoted piling or concrete piling be used. With the present easy means of transporting the pests and infecting waters heretofore immune, it becomes only a question of time until all coastal waters of the United States will be infested by *teredo navalis* as well as by the other marine borers.

A. A. BROWN,
Designing and Construction Engineer.

San Francisco, Calif., Feb. 6, 1935.

Oldest Pile Bridge

Sir—In your issue of Nov. 15, 1934, p. 616, there appears an article entitled "Maine Recreates the First Pile Bridge in America." In the interest of accuracy, I wish to call your attention to an agreement filed in Bridge Book No. 1, p. 9, in the office of the clerk of courts at West Chester, Chester County, Pa. I have tried to retain the original punctuation and spelling as far as possible in the following, although in a few cases the writing has been such that I am not sure that I have exactly succeeded. The agreement follows:

"Articles of Agreement Indented Made & fully Concluded upon, on the First Day of October in the Year of our Lord One Thousand Seven Hundred and Thirty Nine, Between Sam'll Lightfoot John Parry and Joshua Thomson, Gen'l: Comissioners of the County of Chester of the One Part and Nathan Worley and John Dutton of the County of Chester aforesaid in the Province of Pennsylvania Carpenters of the Other Part Witnesseth that the Sd John Dutton and Nathan Worley have agreed with the above named Commissioners to Rebuild and Repair Ridley Bridge and Chichester (or Marcus Hook) Bridge after the following Manner Viz: To Drive Seven Good Sufficient Piles in One Teer at the East End of Ridley Bridge near the Creek Side and also to drive five Good piles in the Said East End of the Causeway which Said Piles & Caps all are to be of the best of Pine and Cap'd or Cover'd with the like Timber Sufficient to Support the Sleepers of the Said Bridge and to Lay Seven Good Sound Sleepers of White Oak on Each Teer after the following Manner," etc.

This agreement to *repair* the bridges would indicate that these pile bridges had been in use for a considerable period prior to 1739 and indeed other records indicate repairs were made to the Ridley bridge in 1716.

From the above I think there can be no question that pile bridges existed in Chester County before 1761, when Sewall's Bridge was built at York Village, Me.

HARRY K. ELLIS,
County Engineer, Chester Co., Pa.

West Chester, Pa., Dec. 20, 1934.

Thickness of Flexible Pavement

Sir—In the interview with John S. Crandell, professor of highway engineering, University of Illinois, (*ENR*, Nov. 22, 1934, p. 658) there appears the following formula:

$$t = \sqrt{\frac{P}{S}} = .0564\sqrt{\frac{P}{S}}$$

Where t = thickness of pavement in inches, P = wheel load in pounds, and S = safe bearing power of the subgrade in pounds per square inch.

It is apparent that the final form of this formula should have been:

$$t = .564\sqrt{\frac{P}{S}}$$

This gives results quite different from those implied in the paragraph which followed. But it does give results comparable with those given by the Harger and Bonney formula, which takes the following form:

$$t = \sqrt{\frac{P}{3S} + \frac{T^2}{9}} - \frac{T}{3}$$

in which t, P and S are the same as before and T is the tire width in inches.

A comparison of values of t given by the two formulas will be of interest. The following table gives such values for a range of S from that of a very soft plastic subgrade to that of an extremely hard compacted one. P is taken as 13,500 lb., representing a commonly assumed maximum static wheel load of 9,000 lb. plus a 50 per cent allowance for impact. T is taken as 10 in. For

narrower tires, the values of t given by the Harger and Bonney formula would be greater, approaching the values given by the Downs' formula.

Nature of Subgrade	Value of S in Lb. per Sq.In.	Value of t By Downs' Formula, In.	Value of t By H. & B. Formula, In.
Very soft and plastic	5	29.31	26.85
Soft and plastic	10	20.72	18.14
Fairly hard	20	14.65	12.03
Hard	30	11.96	9.36
Very hard	40	10.36	7.79
Extremely hard	50	9.27	6.72

It is encouraging to find reference to any of the several formulas for thickness in discussions of flexible pavements. Many builders of flexible types (but fortunately not all of them) have rather completely avoided any attempt to fix pavement thickness by an analysis of the forces involved. This departure from the traditional engineering method of design has undoubtedly been the cause of much unsatisfactory pavement, requiring frequent reconstruction or strengthening, accompanied by high maintenance costs.

E. M. FLEMING,
Highways and Municipal Bureau,
Portland Cement Association.

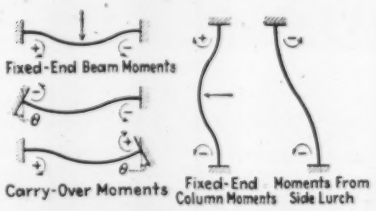
Chicago, Ill., Dec. 20, 1934.

Sign Conventions

Sir—There are few subjects in the field of structural analysis about which there is so much variation of opinion and so much confusion as the subject of signs for the bending moments in continuous frames. This matter is of great importance, as is evidenced by the question that has always attended the significance of signs in the slope-deflection method. In its inception the slope-deflection method was tied up with a sign convention which dealt with the resisting moments acting upon the ends of a span, but since the designer thinks in terms of the moment in the beam itself the result has been a needless confusion.

Robins Fleming (ENR, Feb. 14, 1935, p. 257) issue discusses several sign conventions that may be used in balancing moments. He does not mention the convention used in the slope-deflection method, which might be applied to the method of balancing moments but which fortunately has not as yet been suggested. He does compare the original sign convention chosen by Professor Cross with the one suggested by the writer. Professor Cross prefers the sign convention associated in a study of strength of materials with the fiber stresses in beams. The writer has suggested the simple sign convention that an end moment which tends to rotate the adjacent joint clockwise shall be taken as positive. This latter convention of signs has the following advantages:

1. Columns, girders, and diagonal member are handled in exactly the same manner. There is no supplementary sign convention needed such as the device of rotating the calculation sheet until a vertical column takes the position of a horizontal girder.



SIGN CONVENTION used in balancing moments in continuous frames wherein the moment sign corresponds to type of curvature in the member.

2. The algebraic sum of all moments around a balanced joint is zero.

3. All balancing moments at a joint produced by a single balance have like signs, and their sum is equal and opposite to that of the unbalanced moment.

4. The carry-over moment is of the same sign as the balancing moment.

5. The sign of the end moment corresponds to the type of curvature existing in the member at the joint, as illustrated herewith; and, therefore, there is a direct and self-evident connection between the signs of the end moments and the physical action of the structure at each step of the procedure.

It seems that these listed advantages are sufficient to justify the use of the suggested convention of signs, and, in point of fact, it has been widely adopted. On the other hand, it is important to realize that Professor Cross's convention and the writer's convention should be viewed as supplementary rather than antagonistic. Both conventions are necessary in an analysis by the method of balancing moments. Professor Cross must interpret the signs of the end moments in terms of clockwise or counterclockwise rotation when checking the distribution of moments by the equation $\Sigma M = 0$ at each joint. The writer must interpret his signs in terms of fiber stresses before drawing a final moment diagram. Hence, since both sign conventions must be used, there seems to be no reason why each should not be applied to that part of the procedure where it is most advantageous.

L. E. GRINTER,
Professor of Structural Engineering,
A.&M. College of Texas.

College Station, Tex. Feb. 20, 1935.

Partial Payments

Sir—In a letter from H. C. Long, relating to partial payments on government contracts, (*ENR*, Dec. 13, 1934, p. 769), Mr. Long indicates that the government does not, in its partial payments to contractors, include the value of materials delivered at the site nor the cost of preparatory work. He evidently refers to Treasury Department practice.

The Bureau of Yards and Docks is responsible for the design and construction of public works and public utilities of the navy, and utilizes in its construction contracts standard government form of contract No. 23. Article 16 of this form reads in part as follows:

> Unless otherwise provided in the specifications, partial payments will be made as the work progresses at the end of each calendar month, or as soon thereafter as practicable, on estimates made and approved by the contracting officer. In preparing estimates, material delivered on the site and preparatory work done may be taken into consideration.

A similar clause is included in PWA form 51, U. S. government form of contract, for projects financed by the Federal Emergency Administration of Public Works.

Paragraph 30 of "General Provisions," forming a part of specifications for contracts for public works under the Bureau of Yards and Docks, requires the contractor to submit an itemized schedule of prices on forms provided for the purpose. This schedule is checked by the officer in charge and, when approved by the bureau, governs the preparation of monthly estimates.

In making out this schedule allowance may be included for perishable material delivered at the site when, in the opinion of the officer in charge, it appears that such material will be worked into place within a reasonable time after date of delivery. Allowance may also be made for such temporary work as is of intrinsic value to the government for the time being, such as cofferdam, sheetpiling, cribwork, concrete forms, scaffolding, etc., when such work constructed in accordance with general plans submitted by the contractor is in place and completed and found by the officer in charge to be sufficient for the purpose for which it is constructed. Of course, it is required that any payments on account of such temporary work shall not be disproportionate to the value of other work included in the schedule, and it is understood that payment for such temporary work places no responsibility on the government for the success or failure of the structure on account of which payment is allowed.

Contractors doing work for the Bureau of Yards and Docks, Navy Department, may, and actually do receive payment for temporary work and also for materials delivered to the site without the stipulation that they "be satisfactorily executed in place."

NORMAN M. SMITH,
Chief, Bureau of Yards and Docks, Navy Department.

Washington, D. C., Jan. 30, 1935.

Correction

In the report of the Illinois Society of Engineers' meeting, published in our issue of Feb. 14, the reference to the Michigan City and Hammond, Ind., water-treatment plants (second paragraph in the center column of page 245) did not give proper credit to William E. Stanley. Mr. Stanley's paper discussed the subject of cost as it affects the economic design of sewage and water-treatment plants.

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March 7, 1935

Black Chamber Tactics

CHARGES of irregularities in payrolls and attempt to deceive the United States, followed by seizure of the records of the contractors for Boulder Dam, should be disregarded until facts proving criminality are presented. The conditions of open accounting and close auditing under which the expenditures for Boulder Dam have been made, as well as the rectitude of the federal bureau and of the contractors and engineers involved, make the truth of the charges highly improbable. Until conclusive proof of wrongdoing is brought forward, the engineering and construction organizations that have advanced the great dam beyond all precedent in volume and speed of construction are entitled to thorough confidence.

A Research Opportunity

CONCEPTIONS of mineral aggregates as inert elements in road-surfacing mixtures are rapidly being reversed. Experience and experimentation are demonstrating that an aggregate may be sound and durable and may be graded to perfect mechanical stability and yet, in combination with a hydraulic cement or bitumen binder it may be an element of unsoundness. Possibilities of excess of temperature and moisture movements, change of volume and other qualities of soundness and stability of road mixtures are being determined to lie in characteristics of aggregates. These facts, as brought out in this issue by the senior engineer of tests of the federal highway authority, point urgently to extended research. In large measure experimentation until now has shown that aggregate characteristics account for certain faulty behavior experienced with road mixtures. Of what nature these characteristics are, past study tells little, and still less does it tell why they have the action attributed to them. Research has this important fundamental study to pursue, and it offers a fine opportunity for some ambitious laboratory director to serve highway engineering.

Mechanized Concrete Production

RECENT EXAMPLES of concreting plant afford striking illustration of the progress made by equipment engineering in creating precise production plant for such field operations. Latest among numerous examples from current practice is the Norris Dam concreting plant, recently described, where, in addition to providing large output capacity, it was necessary to adapt the plant to varying composition and quality of product on instant notice. Only a high degree of mechanization and perfected automaticity of action can make it possible for such a plant to supply in its regular stride a wide range of mixtures with workabilities adjusted to the conditions of the moment as called for by the construction engineer. The results attained give proof of success in meeting these demands; at Norris the regular production of more than 2,000 cu.yd of concrete a day gave testimony to the smooth and effective functioning of such complex equipment—by no means less efficient for being temporary installation. Norris Dam is only an individual example, of course; the concrete construction art as a whole today enjoys the advantage of having highly precise and flexible production plant at its command.

Rockfill Dam Design

THE INADEQUACY of fundamental engineering knowledge in the field of rockfill dam design and construction, which was noted in these pages several months ago when the redesign of San Gabriel Dam No. 1 was recommended by a consulting board, is reemphasized by the review of San Gabriel Dam No. 2 construction appearing in this issue. This 265-ft. rockfill structure, of usual design characteristics, was nearing completion when a subsidence of as much as 12 ft. occurred following a torrential rain. Displacement of the concrete facing and the possibility of continuing settlement resulted in the plan to put on a temporary timber facing. This example of rockfill dam behavior adds to the general fund of information on the subject, but it is doubtful whether it will produce enough definite information as to internal action to permit any more rational approach to establishment of a fundamental basis of design or construction procedure. Because the behavior of a fill of rocks under its own weight, with the force of the water on its upstream face, together with the influence of seepage and rainfall, is impossible of exact mathematical determination, knowledge must come from an accumulation of data from field records with supplemental laboratory studies. Therefore, a worthy field of research would be the compilation and analysis of all available information on the history of existing rockfill dams. Only by this means can we hope to develop rational designs for structures that do not lend themselves to full laboratory study.

Red—Stop!

IT IS PROBABLE that in the general breakdown of the American people's respect for law a large share of blame rests on the multiplicity of traffic "don'ts" and conflicting regulations. Therefore, as we strive to return to law observance, some one basic element of traffic control should be set up as a sacred axiom of lawfulness. That sacred thing, obviously, is the red light—the mandatory signal which no law-abiding citizen ought to pass without stopping. In the standards set up by the National Conference on Street and Highway Safety, to which every city should conform, the red danger signal is given this vital traffic task of bringing vehicles to a stop. It is old in this service. Since time immemorial the lantern or red flag has been the protective signal at a temporary street obstruction, such as a pile of building materials, holes in the pavement or barricades. Unfortunately the same signal was adopted in another meaning when permanent obstructions such as safety islands and center light posts were installed for guidance; *here red did not mean "Stop."* In consequence we now have a great diversity of red indications, and the color is in danger of losing its outstanding significance. Chicago with its new consolidated park board has recently made a drive on the 'red" confusion. All red lenses in stop-and-go signals, to

indicate change, are to be replaced by yellow; turning on red will be forbidden unless a green arrow shows; red flashes on safety islands are to be replaced by yellow, as are stationary red lights on center posts, railroad abutments and other permanent obstructions. And finally, to help the colorblind, red will always be placed at the top of the signal series. This is progress toward safety and toward making law-observance easy. May it speed the day when "Thou shalt not run on the red" is recognized as an eleventh commandment.

The Engineer And His Structure

INTUITIVE perception of structural action, joined with skill in adapting materials efficiently to the desired action of the structure which he builds has ever been a distinguishing characteristic of the master builder. Today these qualities hold the same high rank as in earlier times. The first essential of success is that the engineer know his structure, that he have a clear understanding of its behavior under various forces and under the effect of weather and time.

Quite properly, then, the choice of type of structure receives much attention. What is less often remembered is that choice of type does not necessarily fix the action of the resulting structure, and that a large measure of control over its behavior remains in the engineer's hands as a powerful tool.

In primitive days there was little to guide the perception and adaptation of structural behavior other than memory of experience in building some closely similar structure. Analysis later gave new insight, by making it possible to transfer experience from other conditions, even from the testing machine. However, depite marvelous progress, analytical investigation remains only an aid to the engineer's essential function in shaping the structure that he builds.

An engaging discussion before the American Concrete Institute recently bore on this part of the engineer's work. Prof. Hardy Cross spoke of the design of indeterminate structures and took the frame—the so-called "rigid" but actually elastic frame—as his special illustration. He showed that the type name covers a range of structures approaching several functionally distinct kinds. Such a frame may be, or rather *may be made*, a combination of fixed beam on pier supports, or a simple beam with flexible supports, or a corbeled pier with outboard support, or a normal elastic frame. It is for the designer to determine which it shall be.

The wide range of variation in structural action and the extent of the engineer's control over it is well enough known, but not always is it put to fullest use. Everyone knows that a wall is always more than a vertical support, that it is a brace and a prime element of stability of the building; but the extent to which proper plan and proportions utilize this function varies greatly, with corresponding influence on the service of the structure. A floor likewise is both a carrying slab and a tying and stiffening diaphragm. A bridge arch and its roadway may operate as a fixed beam. A dam in a narrow gorge may be made to serve as plug rather than as wall or arch.

It follows that on many occasions the engineer does his most important work in the planning of a structure before detailed analysis and proportioning are taken up. The form of structure which he adopts, sometimes by intuition born of experience and sometimes as the end result of many trial-and-error calculations, has more fundamental influence on the efficiency, economy and service value of the work that he builds than does the detail shaping and proportioning. Just as the locating engineer's discovery of the key points of his location or the architect's preliminary sketches control the value of the final result, so does the structural engineer's initial shaping of his structure.

What this implies is that the engineer must know thoroughly not only the form of structure that he finally chooses but also each of its variants and each alternative type. In addition to knowing their ideal state and application, he should be able to judge of their relation to all probable change in external factors—foundation conditions, variations incidental to construction, expansion effects, repeated loading, settlement and weathering. The key to success in the important first step of structural design is comprehensive and yet detailed understanding of all the factors that influence structural behavior.

De-Aired Paving Brick

KNOWLEDGE of the physical properties that recommend de-aired brick as a paving material needs to be extended. The figures given on p. 308 of our February 28 issue, which are as inclusive as any so far made known, clearly indicate that an exceedingly strong, dense, tough and wear-resisting new product has entered the paving-brick market. Nevertheless, these figures are few in number, haphazard in origin and not always in agreement—conditions that may be expected in the case of a new product whose production technology is not yet fully worked out for all raw materials and all manufacturing conditions, but one that should not long continue if the product is to command unquestioned recognition.

Definite test records of de-aired brick are required. No doubt increased manufacturing experience will make production processes more certain and will enable a stabilized product to be developed by trial-and-error methods. Research, however, offers a shorter road to stabilization. Some of the way has been cleared by the new research bureau of the National Paving Brick Association. Further promise of useful results lies in the decision of the Bureau of Public Roads to undertake tests at its Arlington laboratories. The brick manufacturer will have independent test records by which to guide his production experiments, and the paving engineer will possess the facts needed for specifying his material. This is important.

It is becoming evident, also, that specifications for paving-brick quality need to be extended. Better transverse-strength tests than are now used, and more precise tests of wear and toughness than the time-honored rattler test are likely to be developed. Strength requirements will be tentatively named in some of the specifications for this year's brick paving, but a larger volume of test records is required before exact specification can proceed much further. The results from the laboratories of the Bureau of Public Roads should provide these data. If the possibilities of improved brick quality due to de-airing are to be capitalized, it can only be through higher requirements set by rigid specifications based on adequate information obtained from comprehensive studies.

CURRENT NEWS

Work-Relief Bill Reported Back to Floor of Senate

THE Administration's $4,880,000,000 bill was reported back to the Senate by the Appropriations Committee March 5 after defeating the McCarran prevailing-wage amendment by a vote of 12 to 12. The bill was scheduled to be brought up on the floor of the Senate March 6, and Washington observers believed that the Administration would not have let the bill out of committee unless a tally of the Senate showed that the McCarran amendment would be defeated on the floor.

Funds earmarked

In line with previously indicated concession by the Administration, the committee adopted 14 to 6 an amendment earmarking the bulk of the appropriation as follows: highways, roads and grade-crossings $800,000,000; rural electrification $100,000,000; housing $450,000,000; projects for professional and clerical persons $300,000,000; Civilian Conservation Corps $600,000,000; public works projects of states $900,000,000; sanitation, prevention of soil erosion, reforestation, etc., $350,000,000.

An amendment offered by Senator Glass provides that the President may increase any of the statutory allocations by a sum not to exceed 20 per cent.

The committee defeated without a record vote an amendment to reduce the appropriation to $2,880,000,000. Senator Townsend's effort to provide that the appropriation must first be financed by bonds before becoming available was defeated without a record vote.

Senate Resolution Asks Report On PWA Expenditures

A resolution by Senator Byrd of Virginia calls for a report by the Secretary of the Treasury on the amount and distribution of expenditures under the original appropriation of $3,300,000,000 for public works in 1933. "We have been denied any information regarding the plans for future spending but," declared Senator Byrd, "they at least ought to tell us what's happened in the past. The Virginia senator's resolution directs the Treasury to report:

The total cash disbursed to March 1, 1935.

The balance unexpended.

A list of projects for which the money has been spent.

A list of future allocations to which the government is obligated but has spent no money.

A list of projects for which money was allocated but subsequently impounded.

A list of allocations of public works moneys that have been diverted to pay other government expenses.

Copies of memoranda or agreements committing the government to buildings on which no money has yet been spent.

Grade Separation Financing Effected By Court Decision

The protest of the railroads against assessments for grade crossing elimination for the benefit of their highway competitors was heeded by the U. S. Supreme Court this week. In a decision by Justice Louis D. Brandeis, the court remanded to the Supreme Court of Tennessee a suit by the Nashville, Chattanooga & St. Louis Railway against an assessment of $8,700 for half the cost of building an underpass near Lexington, Ky. The court held, in effect, that consideration must be given to changing economic conditions in passing on the validity of laws long on the statute books.

The Tennessee court was directed to determine whether the cost would burden the railroad and to consider in this connection the extent to which grade crossing elimination was designed to foster transportation which would compete with the railroad, and the extent to which it was undertaken as a means of affording work-relief for the unemployed. The court indicated that the findings on these premises would justify a reduction in the assessment or invalidate it completely.

Consulting Board Appointed For San Jacinto Tunnel Work

The employment of a board of consulting engineers to report upon problems in connection with the construction of the San Jacinto tunnel of the Colorado River aqueduct has been provided by the board of directors of the Metropolitan Water District. F. E. Weymouth, chief engineer of the district, was granted authority to select the consultants. Members of the board selected up to Feb. 26 include:

D. H. Reddinger, superintendent, Big Creek Division, Southern California Edison Co.; J. Fred Johnson, Salt Lake City, consulting engineer for the United States Bureau of Mines; W. R. Fontaine, San Francisco, tunnel consultant for Six Companies Inc.; and Thaddeus Merriman, consulting engineer, New York City, and a member of the original consulting board of the Metropolitan Water District. Additional members may be appointed later.

Parker Dam Restraining Order Argued Before Supreme Court

The United States Supreme Court heard argument March 4 on the complaint of the Federal government in the original suit to restrain Arizona state authorities from interfering with construction of Parker Dam, on the Colorado River, a part of the Boulder Dam project. As justification for calling out state troops, James R. Moore, special assistant state attorney general, contended that when workmen went into Arizona territory it was an invasion of the rights of a sovereign state.

Mr. Moore argued that the federal government had no authority to build Parker Dam either as a means of improving navigation, controlling floods or irrigating land. Harry W. Blair, assistant attorney general, defended the legality of the project.

Boulder Dam Payroll Is Impounded By Federal Court

BASED on an affidavit reported to have been made by a former employee of the Six Companies, Inc., contractor for the Boulder Dam, the United States Attorney's office in Nevada has impounded the records of the contractor on instructions reported to come from the office of Attorney General Homer F. Cummings. The affidavit contended that the eight-hour law has been regularly violated on the project and that penalties provided for such violation in the contract have not been paid.

Secretary Ickes, in press conference Tuesday (Mar. 6) said that a telegram he had received from the Six Companies stated their affairs and records were ready for inspection at any time and "would bear the full light of day." The telegram was not made public. The situation, according to a Department of the Interior release, "has reached such proportions that Sec. Ickes ordered (Mar. 3) Louis R. Glavis, Director of Investigations to go personally to Boulder City."

Records seized

The local United States Marshal, accompanied by representatives of the U. S. District Attorney took possession of all time-records, payroll checks and other documents covering the period from March 1931, to December 31, 1934 at the office of the Six Companies in Boulder City and transferred them to Federal Building in Las Vegas. United States Attorney Carville announced that a complete audit would be made.

Books always open

A statement which is reported to have been made by F. E. Crowe, general superintendent of the Six Companies Inc. to the local press included the following:

"Our books have been opened to officials of the United States Government from the start of the job.

"They have been gone over from time to time by officials from the Public Works Administration, Internal Revenue and Department of Reclamation.

"We have kept two payrolls, one for regular payroll and the other for emergency over-time and bonus. We have a bonus system under which our employees are given bonuses for all concrete poured over a certain amount. These bonuses and any over-time work due to emergency are kept track of in this 'emergency-bonus' payroll.

"We have been charged $1,145 for overtime penalties by the Bureau of Reclamation and have protested vigorously.

"We have submitted payroll figures each month to the Reclamation officers showing our total payroll figures including the emergency bonus payroll and the regular payroll. These figures have also been given to the press."

IN WASHINGTON

By Paul Wooton
Washington Correspondent

With the Senate Appropriations Committee again reporting the work-relief bill early passage of the measure without fundamental change from that originally introduced is foreseen.

Investigation of the Boulder dam contract is expected to deflate charges and rumors that have been in circulation. Those who have been close to the work feel confident that no irregularity of moment could have escaped detection.

Since those who will be in charge of the NRA investigation are not in sympathy with the law or the manner in which it has been administered, it is expected that critics of NRA will have every opportunity to air their views. Unless something now unforeseen is revealed, Congress is expected to be little influenced by the investigation proceedings. Indications all are that NRA will be extended with due consideration to the suggestions in the President's message.

The Construction Code is not expected to come in for particular attention at the NRA investigation, since there is no monopoly in that industry and since there has been no complaint from small operators.

A brief has been filed with the Supreme Court of the United States on behalf of Nebraska opposing the motion of Wyoming to dismiss the suit over the apportionment of the waters of the Platte and the North Platte rivers.

A.S.C.E. Names Walter E. Jessup To New Post of Field Secretary

Walter E. Jessup, has been appointed to the newly created position of Field Secretary of the American Society of Civil Engineers. The new post, an outgrowth of the study and recommendations made by the Committee on Aims and Activities, was authorized by the Board of Direction of the society, at its January meeting. Mr. Jessup has been editor of *Civil Engineering* since that publication of the society was started in 1930.

When the publication of *Civil Engineering* was initiated it was the intent of the society at that time to have Mr. Jessup take over such duties as have now been defined as those of the Field Secretary, as soon as the publication was organized and well established. During the intervening years the finances of the society have not permitted this expansion.

Mr. Jessup was born in Pasadena, Calif., in 1888 and is a graduate of the University of Southern California, in 1910, and received his degree of civil engineer from the University of Wisconsin in 1912. Following a variety of engineering work in Southern California on aqueduct, hydro-electric and state highway work, Mr. Jessup's professional activity was interrupted by 16 months of service in France during the war as a first lieutenant with the 39th Engineers. Returning to Southern California he was employed by the consulting firm of Quinton, Code and Hill on investigations and valuation work until 1924 when he opened a consulting office in Los Angeles, in partnership with Henry E. Osborne.

Public Works Inventory Reaches $14,000,000,000 Total

Public works projects totalling nearly 100,000 and estimated to cost approximately $14,000,000,000 have been reported to the PWA in its national inventory of potential work projects. These figures do not include the final week's report of the state PWA engineers. Three states—New York, New Jersey and Michigan—have each reported projects estimated to cost more than $1,000,000,000.

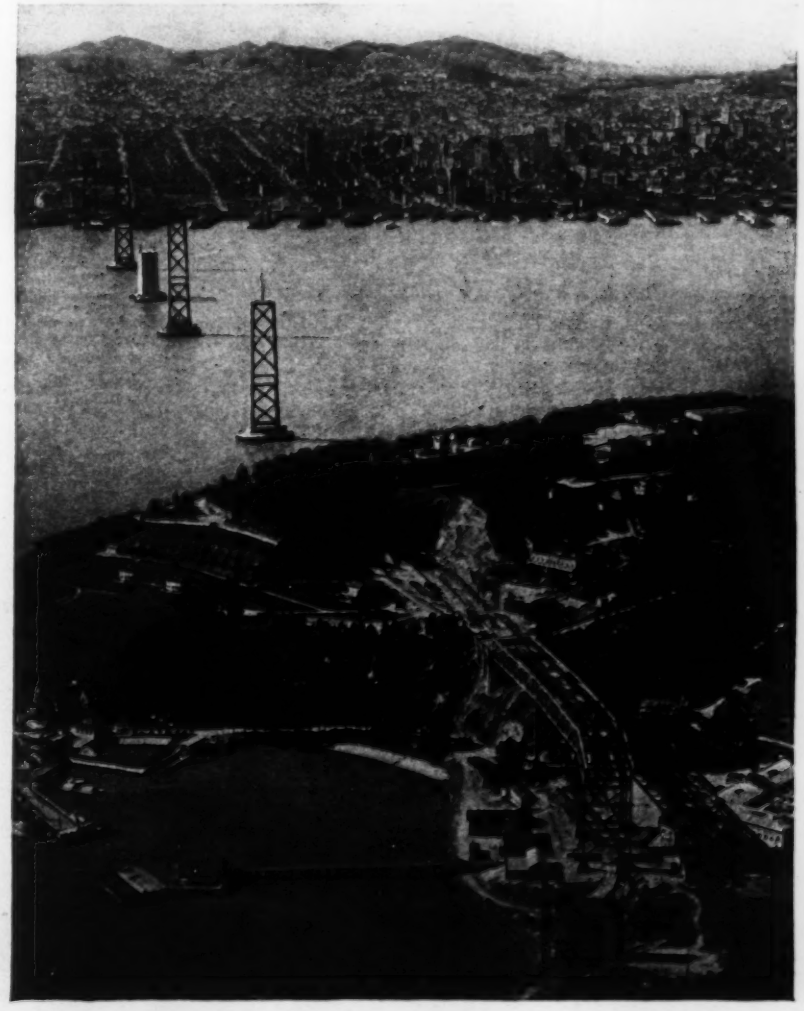
PWA officials pointed out that many in this extensive list of public works projects could not qualify under the existing stringent PWA requirements as to legality and financial soundness. Furthermore, many of these projects have previously been reported to the PWA although the amount of duplication has not been determined. Most of the inventory projects are of the non-federal type.

Federal Judge in Missouri Approves PWA Loan for Power

Federal Judge Faris, at St. Louis, Mo., has dismissed the injunction suit filed by the Arkansas, Mo., Power Co., to enjoin the city of Kennett, Mo., from making financial arrangements with the PWA to construct a municipal light and power plant and distribution system. The private utility company challenged Sections 201, 202 and 203 of the National Recovery Act. Judge Faris, in his decision stated that the power company lacked the right to challenge the NRA, as the United States Supreme Court had held that the constitutionality of an act of congress cannot be raised unless the plantiff shows that the act is invalid and that he has sustained an actual loss. In the present case the company's franchise to operate in Kennett expired in February 1935, and the judge pointed out that it had failed to substantiate a claim of loss.

TOWERS FOR TRANSBAY BRIDGE ABOUT READY FOR CABLES

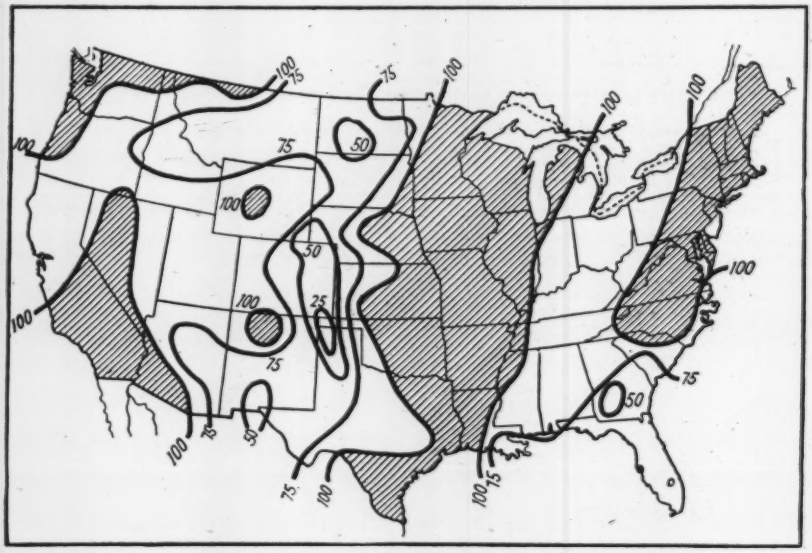
Looking west along the line of the San Francisco-Oakland bridge, with Yerba Buena Island in the foreground. In the lower right is the steel viaduct which will carry the double deck structure between the 1,400-ft. main cantilever span over the East Channel crossing and the east end of the 500-ft. tunnel under the crest of the island. West of the island are the four completed towers, to support the twin 2,300-ft. suspension spans, and the common central anchorage. San Francisco appears in the background across the mile-and-a-half West Channel.



Extreme Drought Conditions Continue On the Western Great Plains

(Washington Correspondence)

IF THE weather map is consulted, President Roosevelt's new work-relief program will be directed in large measure to alleviating the distress of an even more disastrous drought than last year. Extreme drought persists unabated on the western Great Plains. Only copious spring rains will avert a greater shortage of water for grain, range and community water supply than was suffered last year. The drought not only is unrelieved but has been intensified during the winter by lack of normal rainfall. In most parts of this region the supply of moisture in the ground is less than it was a year ago and dust storms prevalent in the spring and summer of 1934 have already swept wide areas. Another summer like last and the exodus of population from this territory will be very large.



PER CENT of normal precipitation for the period from September, 1934, to February, 1935, inclusive. Shaded areas have received normal precipitation.

The government can do little more now than speed emergency relief work in digging wells and waterholes, importing forage, food and water and moving families from hopelessly exposed localities to more favored land. Ambitious projects such as the extensive control of soil erosion, the tree shelter belt, the trans-mountain diversion of water from the Colorado to the Missouri River watersheds and other projects in this region will require years to materialize.

Even the irrigation districts will have a hard time squeezing by another summer of evaporating heat. The mountain snow pack is below normal and east of the 100 deg. meridian the outlook for storage supplies is critical. Storage on hand in reservoirs is 7 per cent less than in the winter following the drought of 1931 and on Jan. 31 totaled only 3,085,150 acre-feet as compared with 5,044,100 a year ago. The Bureau of Reclamation reports that due to extreme depletion of groundwater and storage on several projects last year and accumulated deficiency in rainfall since Oct. 1 only slight improvement in run-off prospects were noted in February for Belle Fourche project in South Dakota, North Platte project in Wyoming and Nebraska, Strawberry Valley in Utah and Carlsbad project in New Mexico. The Riverton project in Wyoming is suffering power shortage this winter due to the depletion of snow banks and glaciers. Assuming future conservation measures, precipitation during January somewhat improved the outlook for the Salt River project in Arizona and the Rio Grande project in New Mexico.

The Weather Bureau reports more or less precipitation, principally snow in parts of the western dry area but this was drifted badly by high winds and severe dust storms swept over western portions of Oklahoma, Kansas, Nebraska, and parts of eastern Colorado and eastern Wyoming. These occurred in the area where there has been very little precipitation since last summer, with soil moisture conditions unimproved and even worse in many places than at this time last year.

In its report Feb. 27 on wheat prospects, the U. S. Bureau of Agricultural Economics says that it is not likely now that the present deficiency of moisture in the extreme western portion of the winter wheat belt can be entirely made up, even if there should be plentiful late winter and spring rains. In the spring wheat region of the northern Great Plains the deficiency of subsoil moisture will probably result in less than average yields unless weather conditions during spring and early summer are more favorable than average.

Periodic drought in this region causes a very serious situation not primarily because of the average deficiency in precipitation as measured in inches but because the normally small amount makes such deficiencies disastrous. In North Dakota for the past five years the accumulated deficiency in rainfall, with the "normal" as a base, is about 16.5 in. While in water volume this is enormous, representing a shortage of more than 1,800 tons per acre, Kentucky has, for example, an accumulated deficiency of more than 18 inches for the same period. Kentucky, however, with a larger shortage based on normal, has had more rainfall in these five years than North Dakota normally receives for a like period.

Budget Increases Funds for Work of Interior Department

(Washington Correspondence)

MORE FUNDS for National Park and Indian Service roads, for surveying public land, stream gaging and topographic surveys accounts to a considerable extent for an increase of $11,910,790 in the 1935-36 appropriation for the Interior Department as compared with the current year's budget. The bill, as reported by the House Appropriations Committee, carries $58,775,656. Apparent increases for many of the Department's activities are offset, however, by unexpended balances and PWA allotments available during the present fiscal year.

The bill carries $4,000,000 for Indian Service roads and bridges, an increase of $2,000,000 to be used mostly in the employment of Indian labor. An appropriation of $950,200 for Indian reservation irrigation and drainage is $159,155 less, but allowance must be made for an item of $400,000 for the Middle Rio Grande Conservancy District this year which does not recur in the 1936 bill.

For the Bureau of Reclamation the bill appropriates from the reclamation fund $1,022,100, which is $161,350 more than the 1935 appropriation. The committee also has inserted in the bill a provision transferring to the reclamation fund an unexpended balance of $138,000 paid into the auxiliary reclamation fund of the Yuma project by settlers.

Appropriation of $2,107,560 for the Geological Survey is $794,060 higher than the current appropriation but an actual increase of only $559,862 as unexpended balances amounting to $234,198 were available this year. Substantial increases for various activities has, the House Committee reported, placed appropriations for the U.S.G.S. on a basis approaching the pre-depression level. An appropriation of $400,000 for topographic surveys represents an increase of $237,860 over the appropriation and unexpended balances available this year. For geologic surveys the bill carries $335,000, an increase of $45,560; for classification of lands, $150,000, an increase of $60,300; and for stream gaging, $617,000, an increase of $130,152 over this year's appropriation of $337,650 and an unexpended balance of $148,198. A reduction of $13,000 in the budget estimate of $630,000 for gaging streams is applied to an estimated increase of $58,000 for repair and operation of federal stations. The committee allowed $45,000 or this purpose.

Appropriation of $15,713,890 for the National Park Service is $4,394,250 more than the current appropriation. The substantial increase is accounted for principally by an additional $2,500,000 for roads and trails, making a total of $7,500,000 for this purpose.

Several Legal Moves Affect Silicosis Suits in Missouri and West Virginia

THE GRAND JURY of Iron County, Mo., has returned indictments against Russell J. Horsefield and A. F. C. Blase, attorneys, on charges of barratry (defined as the practice of exciting and encouraging lawsuits) in connection with silicosis damage suits brought against the Pilot Knob Ore Co. in 1933. Both are to be tried in the April term of court. Charges against Blase state that he attempted to incite certain employees "telling them that they had contracted silicosis or some occupational disease while working for the Pilot Knob Ore Co., all to the common nuisance of the people. . . . and against the peace and dignity of the State." The Horsefield indictment is on similar charges.

Company seeks receivership

To protect its assets against heavy damages sought by several employees alleging contraction of silicosis while working in lime kilns at Glencoe and Glen Park, Mo., the Glencoe Lime & Cement Co. consented on Feb. 12 to the appointment of a receiver by Circuit Court Judge O'Malley. The court also granted an injunction against Cosmer Alexander, a former employee who obtained a judgment for $22,500 against the company on the grounds he is suffering from silicosis, from obtaining an execution on the company's property to satisfy the claim. The injunction also restrained other former employees from proceeding with silicosis suits, and furthermore prohibits the filing of additional suits. Later reports state that on Feb. 21 Judge O'Malley set aside the receivership of the lime company on motion by counsel of Alexander, though no mention was made as to whether the injunctions still stand. It is also reported that Alexander has assigned his judgment to Attorney Horsefield, one of the two under indictment for barratry.

During the past few years hundreds of suits based on silicosis have been filed in the federal and state courts of Missouri against various cement, sand, gravel, lime, lead and glass companies. The total is estimated to exceed $15,000,000. Recently Circuit Court Judge Joynt held that a damage suit on the grounds of silicosis must be brought within five years from the time the disease first became apparent. If upheld this ruling would apparently eliminate many of the suits.

Tunnel cases in change of venue

The Fayette County, W. Va., Circuit Court has granted permission for a change of venue for 60 suits filed against Rinehart & Dennis Co., contractors of Charlottesville, Va., from Fayette County to the Circuit Court of Kanawha County at Charleston, W. Va. These suits allege contraction of silicosis in connection with the driving of the 3-mile Hawks Nest power tunnel for the New-Kanawha Power Co. In 1933 the first case tried of several hundred suits filed ended in a jury disagreement in the Fayette County court. The contractor then settled most of the cases out of court, only to be faced with another batch of suits in 1934. The first case tried of these suits likewise ended in a jury disagreement. Then the plaintiffs sought a change of venue. An appeal against the change made by the defendant before the Supreme Court of the state brought only the ruling that a change of venue order, in itself, is not reviewable.

Change Made in Dam Program of Muskingum District Project

Changes have been announced in the plans for the proposed Dover Dam in the Muskingum conservacy project which will lower the spillway elevation four feet as a result of substituting the Bolivar Reservoir for the Massillon Reservoir. This change will reduce the estimated cost of the Dover Reservoir work, including the concrete dam, railroad and highway relocations, from $5,978,000 to $5,360,000. The change will also result in eliminating and reducing levy construction.

Railroad relocation

Bids for the first railroad relocation work in the district program will be open March 11 which will include work on 5.82 miles line of the Pennsylvania railroad, between Dover and Mineral City. In all, about 26 miles of railroad relocation will be necessary in the Dover reservoir site; this work will cost about $2,000,000.

Survey of Nations Schools Shows $625,900,000 of Work

A survey conducted by the Office of Education, Department of the Interior, indicates that $625,900,000 could profitably be expended at once for school building construction throughout the country. This estimate has been reported to Administrator Ickes based on the returns from 24 state departments of education, and half of the cities of more than 2,500 population in 45 states.

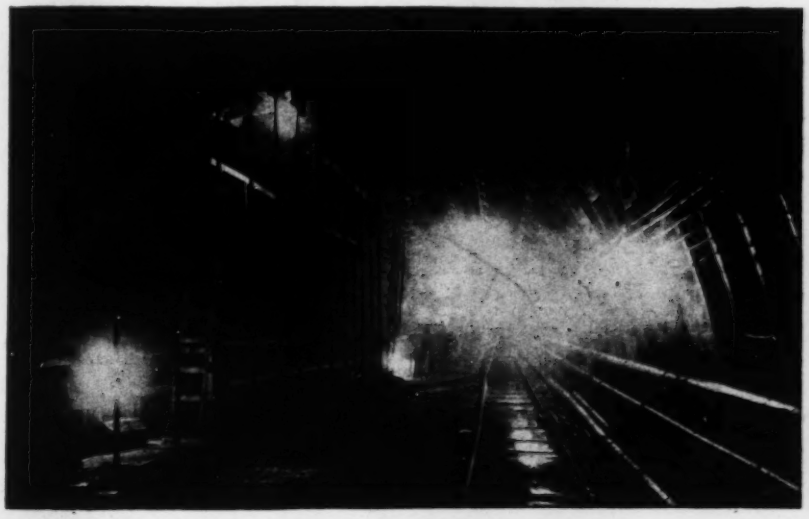
More than half of the schools constructed in 1934 were financed by PWA allotments. Although the survey was not complete, nearly 13,000 school building projects were reported.

WORK PROGRESSES ON VEHICULAR TUBE UNDER THE HUDSON BETWEEN NEW YORK AND NEW JERSEY

TWO views of the New Jersey end of the Mid-town vehicular tunnel being driven under the Hudson River by the Port of New York Authority to connect 38th St., Manhattan, with Weehawken, N. J. Left: Looking towards the shield, showing the cast-iron lining in place. The narrow-gage tracks, over which the lining segments are moved to the face, are carried on steel beams supported by hangers from the roof. Right: Checking the alignment of the shield from one of the control points established in the roof of the tunnel.

The external diameter of the tunnel is 31 ft. 8 in., which is larger than the Holland tunnel a mile and a half downstream. Present plans for the Mid-town project call for one tube only, with two-way traffic using a 20½-ft. roadway.

In connection with present operations, about one-fourth of the total displacement of muck is admitted to the tunnel through two hydraulically-operated doors in the face of the shield. This muck is not removed from the tunnel, but is spread over the bottom to serve as ballast, to counteract the buoyancy of the tube in the river silt. Driving under compressed air is now under way at each end of the tunnel. The Mason & Hanger Co., New York, is contractor.



Clarification of Crushed Stone Code Subject of Hearing

A PUBLIC HEARING has been announced by NRA in Washington for March 21 to reconsider the definitions of the code for the Crushed Stone, Sand and Gravel and Slag Industries which is in need of clarification. It is understood that this reconsideration may result in amending the definitions to restrict the coverage of the code.

The code for these industries, approved Nov. 10, 1933, includes the quarrying, crushing, processing and recovering of stone, sand, gravel or slag for any or all purposes. The "Crushed Stone Producer" is defined as any member of the industries engaged in the quarrying, crushing or processing of stone for any or all purposes.

Other codes have been granted by NRA covering the production of stone for various purposes, as, for instance, the limestone industry; marble quarrying and fabricating and building granite industries, the latter being a division under the construction code. The building granite division of the construction industry includes quarrying and fabricating of granite for architectural and construction purposes. It is reported that this code claims jurisdiction over the processing of granite for use in breakwaters, riprap or jetty stone.

Other questions involved are the operations of contractor producers who produce either crushed stone or sand and gravel for a particular job and not in direct competition with commercial producers. Questions have been raised whether such contractor producers should be subject to the open price policy adopted in various administrative districts, or to the plant capacity limitations.

On application of the Bureau of Public Roads, an administrative order was approved Nov. 9 granting a limited exemption to all contractor producers of sand, gravel or stone for public highway construction from the provisions of the code in question. The exemption applied to those contractor producers having construction contracts in their own names and where the production of material was from publicly owned or controlled lands. It was also provided that they should in no event employ labor under wage and hour schedules inferior to those provided for in either the material code or the construction code, but utilize whichever wage and hour provisions were superior.

This 90-day exemption expired on Feb. 7, but a second administrative order extended it for a further period of 90 days, or until such earlier time as final determination is made by the National Industrial Recovery Board.

Mexican Highway to be Opened

The international highway from Laredo, Texas, to Mexico City is expected to be open during May of this year, according to a report indicating that only 56 miles of the highway now remains to be completed. About 6,500 men are reported to be at work on the highway which is being widened from 4 meters to standard width. The distance from the International Boundary to Mexico City is 760 miles.

FHA Approves Low-Cost Housing Project Near Washington, D. C.

Preliminary approval of a low-cost housing project, near Washington, D. C., has been announced by the Federal Housing Administration. The project requires an expenditure of about $1,130,000 and includes six groups of two-story apartments built on an 11½-acre tract, fronting Wilson Boulevard, about a mile northeast of Clarendon, a suburb of Washington. Gustav Ring, builder, is organizer of the syndicate sponsoring the project.

A private loan is being negotiated to finance the plan, in accordance with provisions of Section 207 of the National Housing Act. Under the provisions of this section long-term mortgage loans on low-cost housing projects will be insured up to the full value of the buildings, provided the land is unencumbered. Capitalization of such low-cost projects is limited to the actual investment by the stockholders. On this, they may receive regular annual dividends not to exceed 6 per cent, and special disbursements not to exceed 2½ per cent a year, provided an amount equal to that paid in such special disbursements is returned to the tenants in the form of rebates or rent.

This is the second low-cost housing loan approved by the FHA, the first being for a project in Meadville, Pa.

Unusual Unbalanced Snowload Wrecked Vancouver Building

Investigation of the collapse of the huge timber arch roof of the Forum Building in Vancouver, B. C., on Jan. 21, has resulted in a report to the city council that the drifting of an unprecedented snowfall to one side of the roof was the primary cause. The roof of Lamella type (a diamond-shaped lattice network of planks on edge, resting on heavy timber sills tied with steel rods across the building) had a span of 126 ft. and a length of 375 ft. It was supported on a frame of concrete columns and beams. The design of the roof is said to have been based on a 40-lb. per sq. ft. live load, uniformly distributed. No such unsymmetrical load as occurred was contemplated in the design, C. Pantke, of the Lamella Roof Syndicate, New York, told the city investigating committee, since available records and information indicated that snowfalls are not heavy in Vancouver, and what little snow did fall was wet and not inclined to drift. Actually, the snowfall was unprecedented, and an easterly wind drifted the snow to the west side of the arched roof.

PWA Signs Contract For Planning Boston Housing Project

A contract has been signed with a commission of 17 Boston architects to prepare plans for the PWA's $5,000,000 low rent housing project to be built in that city. Headed by Joseph G. LeLand, the architectural group has been selected from the leading architectural firms of the city. Secretary Ickes explained that the large group of architects was selected to spread the benefit of this professional work as far as possible and to expedite the carrying out of the project.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 12-14.

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, meet[illegible], Miami, Florida, April 4-6.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

NEW YORK SECTION, American Water Works Association, spring meeting, Albany, March 21-22.

FLORIDA SECTION, American Water Works Association, West Palm Beach, March 27-30.

CANADIAN SECTION, American Water Works Association, London, Ont., March 27-29.

NEW JERSEY SEWAGE WORKS ASSOCIATION, twentieth annual meeting, Trenton, March 21-22.

PENNSYLVANIA WATER WORKS OPERATORS' ASSOCIATION, annual meeting, State College, June 26-28.

Personals

ALFRED JONES, acting county surveyor of Los Angeles county, has been permanently appointed to that position by the county board of supervisors.

C. J. LOWRANCE, Driver, Ark., has been elected head of the Mississippi Valley flood control chapter of the Associated General Contractors.

JOSEPH SORKIN, bridge designer with the Nebraska State Highway Department since 1929, has accepted a similar position with the Montana State Highway Commission.

H. M. GALLAGHER has resigned as Louisiana state engineer in charge of the works division of the ERA, to become associated with the J. F. Coleman Engineering Co. Prior to his work with the ERA Mr. Gallagher was chief state engineer of the Civil Works Administration.

A. R. BROUSSEAU, assistant state engineer of the ERA in Louisiana, has been made associate state engineer and will assume the duties of Mr. Gallagher.

H. G. GERDES has been transferred from the U. S. Engineer's office at Portland, where he was serving as designing engineer on the Bonneville Dam project, to the permanent staff of the Federal Power Commission, Washington, D. C. Mr. Gerdes' work will be in connection with hydroelectric development under the administration of the Federal Power Commission.

E. W. WENDELL has been appointed assistant chief engineer, Department of Public Works, State of New York. Mr. Wendell began his service in state engineering work in 1908 on the construction of the Barge Canal and in 1913 moved to the State Highway Department and in 1926 was appointed grade separation engineer. The promotion to assistant chief engineer follows twenty-seven years of continuous service in state work.

W. V. BAISE, who has been acting highway engineer of North Carolina since the death of John B. Waldrop last summer, was elected chief engineer by a unanimous vote of the State Highway and Public Works Commission. Mr. Baise has been assistant chief engineer on the North Carolina Highway Commission for the past two years.

Obituary

FRED N. HAVENER, age 65, an engineer in the city department of Waltham, Mass., for many years, died at his home in that city Feb. 26.

EUGENE C. HANAVAN, engineer-inspector of the Bureau of Buildings, New York City, died Feb. 28 at the age of 61. He was a graduate of Rensselaer Polytechnic Institute and had served on the Croton Aqueduct and the early subway work in New York City.

HENRY HEYWOOD FOX, vice-president of the Turner Construction Co., New York City, died at a local hospital, March 14, at the age of 55. He graduated from Harvard University in 1900 and had been associated with several other building organizations before joining the Turner Construction Co., of which he was director as well as vice-president at the time of his death.

W. DEWITT VOSBURY, sanitary engineer and member of the firm of Remington, Vosbury & Goff, Camden, N. J., died March 3, in Philadelphia at the age of 54.

MORGAN T. JONES, president of the Morgan T. Jones Co., Inc., nationally known testing and inspection organization of Chicago, died Feb. 25 in that city at the age of 74. Mr. Jones was a native of Wales.

JOHN GILMORE MCMILLAN, a pioneer among California engineers, died Feb. 14 in San Jose, Calif., at the age of 84. Born in Rhode Island his parents moved to the California mining district four years later. He was known for his early contribution in the field of design and construction of concrete arch bridges. Mr. McMillan constructed a concrete arch highway bridge in 1890-91 in Santa Clara County, Calif.

DANA G. GRIFFIN, who served on some of the first Hudson River tunnel work at New York before going to Fort Worth, Texas in 1910, died in the latter city Feb. 26 at the age of 62. Mr. Griffin remained at Fort Worth from the time he went there in 1910 to become engineering consultant for the city water works department and later superintendent of the system. On the Hudson River tunnel work Mr. Griffin was connected with early efforts to improve working conditions and equipment under air pressure.

DWIGHT PORTER, professor emeritus of hydraulic engineering, Massachusetts Institute of Technology, died at his home in Malden, Mass., Feb. 26, at the age of 80. Born in Hartford, Conn., Professor Porter graduated in civil engineering at Yale University in 1880 and his first engineering employment was on the tenth census of the United States reporting on water power resources. He joined the faculty at M.I.T. and after serving in the mathematics department for one year became professor of hydraulic engineering, a position which he held until his retirement in 1921.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards total $22,799,000 for the week, practically the same volume as last week. Private work is higher again, $7,640,000, the third highest week this year. Public awards are down to $15,159,000 of which $3,643,000 is federal and $11,516,000 state and municipal. The federal volume is an increase and the state and municipal a decrease from last week.

Gains are recorded in industrial buildings at $4,998,000 and earthwork, irrigation, waterways at $2,269,000. Highways are down to $5,560,000, public buildings to $3,926,000, commercial buildings to $1,377,000, waterworks to $527,000, sewerage to $539,000. Public bridge awards totalled $1,798,000 for the week and private awards, $918,000.

The larger awards include: Eastman Kodak factory, Rochester, N. Y., $500,000; hot and cold strip mill for Bethlehem Steel Co., Lackawanna, N. Y., $2,500,000; blooming mill for Inland Steel Co., South Chicago, Ind., $1,000,000; Colonial High School, Kansas City, Mo., $489,000; highway awards by Illinois, $1,000,000 and by New York, $673,000; grade crossing eliminations on Long Island R.R., New York, $750,000; dam, Beach City, Ohio, $844,000 and 10,716,800 cu.yd. dredging, Intracoastal Waterway, So. Car., $1,283,000.

Municipal bond sales for the week include $1,142,000 in sales by RFC of PWA issues, $21,000 sold to RFC, and $4,835,000 new construction issues sold through regular channels to private investment institutions.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1934	Prev. 4 Weeks	Week Mar. 7 1935
Federal Government	$9,000	$2,241	$3,643
State and municipal	13,413	9,660	11,516
Total public	$22,413	$11,901	$15,159
Total private	7,028	5,121	7,640
Week's total	$29,441	$17,022	$22,799
Cumulative to date:			
1934...$321,096,000	1935...$239,152,000		

NEW PRODUCTION CAPITAL

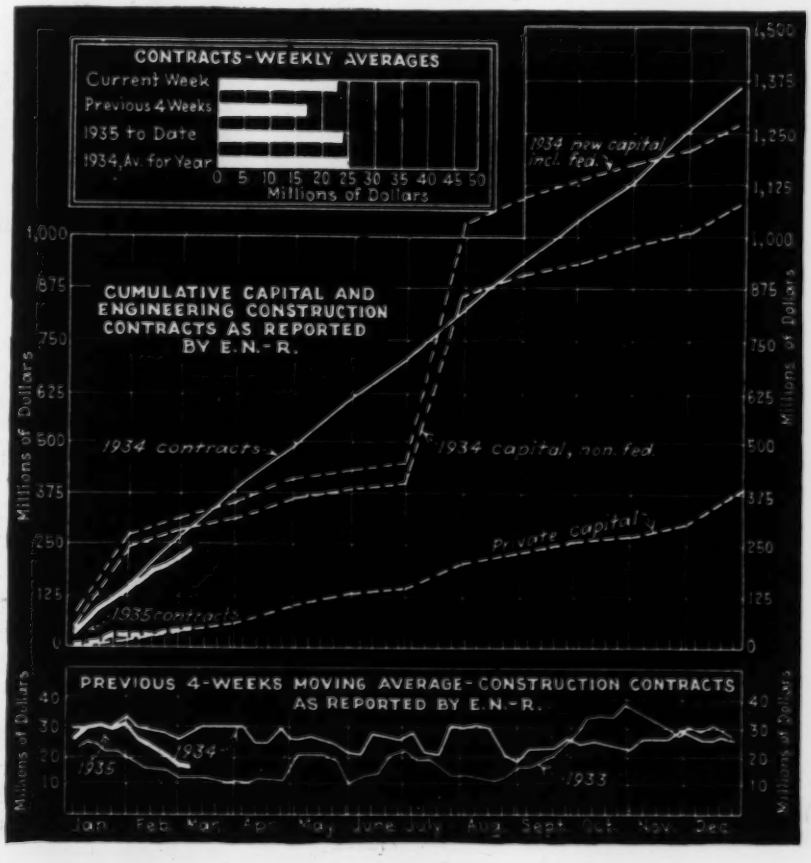
(Thousands of Dollars)

1935	Week Mar. 7	Cumulative
State and municipal	$5,977*	$62,696
PWA allotment, S&M	—1,142	—33,280
RFC loans, S&M	21	84
Corporate issues	....	....
PWA allotments, private	....	....
Total, Non-Federal	$4,856	$36,779
PWA allotments, Federal Constr.	....	7,939
Total new capital	$4,856	$44,718
Cumulative to date:		
1934....$338,001,000	1935....$44,718,000	

*Includes $1,142,000 PWA bonds sold by RFC in private investment municipal bond market.

INDEX NUMBER

E.N.R.- Cost	1913 = 100	1926 = 100	E.N.R.- Volume	1913 = 100	1926 = 100
Mar., 1935	193.46	93.00	Feb., 1935	76	33
Feb., 1935	196.02	95.52	Jan., 1935	130	57
Mar., 1935	194.06	93.20	Feb., 1934	116	51
1934(Av.)	198.10	95.23	1934(Av.)	114	50
1933(Av.)	170.18	81.80	1933(Av.)	102	47
1932(Av.)	156.97	75.45	1932(Av.)	127	56


CONTRACTS-WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934, Av. for Year
0 5 10 15 20 25 30 35 40 45 50
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934 new capital incl. fed.
1934 capital, non-fed.
1934 contracts
Private capital
1935 contracts
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE-CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

BUSINESS SIDE OF CONSTRUCTION

February Construction Volume Low Private Work Up, Federal Down

ENGINEERING construction awards in February dropped to $68,089,000 for a 4-week month. Private work, however, increased to $20,485,000 or from $4,696,000 per week in January to $5,121,000 per week in February. Public awards dropped to $11,901,000 per week or $47,604,000 for the month, of which $8,965,000 was federal work. This compares with a $48,736,000 federal total for 5 weeks last month and $40,365,000 for February last year. The drop in state and municipal work for the month to $38,639,000 was less drastic, from $15,210,000 per week last month to $9,660,000 per week February, 1935. The work going ahead consists of a larger number of medium-sized and smaller projects and fewer of the very large projects that boosted the volume statistics last year. Calls for bids are running steadily higher than a year ago; 137 per week recorded for January compared with 150 a year ago and 236 per week in February compared with 177 per week a year ago.

Highway awards dropped 34 per cent below last month and public buildings 43 per cent below. Industrial buildings dropped 52 per cent from last month's volume but commercial buildings increased 20 per cent. Private work, including cemetery development, improvements to distribution lines and power plants, rails and trackwork, a 10-story apartment house, grade crossing elimination contracts, made up a larger part than usual of the construction volume for the month.

Geographically only, Middle Atlantic territory showed an increase over last month with all other territories showing major losses.

New Capital

The Public Works Administration withdrew in recissions, changes from loans and grants to grants only, sales of bonds through RFC, and decreases of PWA allotments outstanding for state and municipal work, a total of $22,986,000 during February. State and municipal bond sales for the month totalled $32,500,000, including $8,809,000 of PWA bonds bought from RFC. The public Work Administration allotted loans to private organizations during February totalling $3,627,000, and allotted $5,408,000 for federal work.

Materials

Cement—Cement shipments in January totaled 2,846,000 bbls, as reported by the U. S. Bureau of Mines. This volume represents a decrease from January, 1934, of 24.7 per cent. The ratio of production to capacity declined to 14.1 per cent compared with 16.6 per cent a year ago and 19.5 per cent in December.

Steel—The operating rate of steel com-

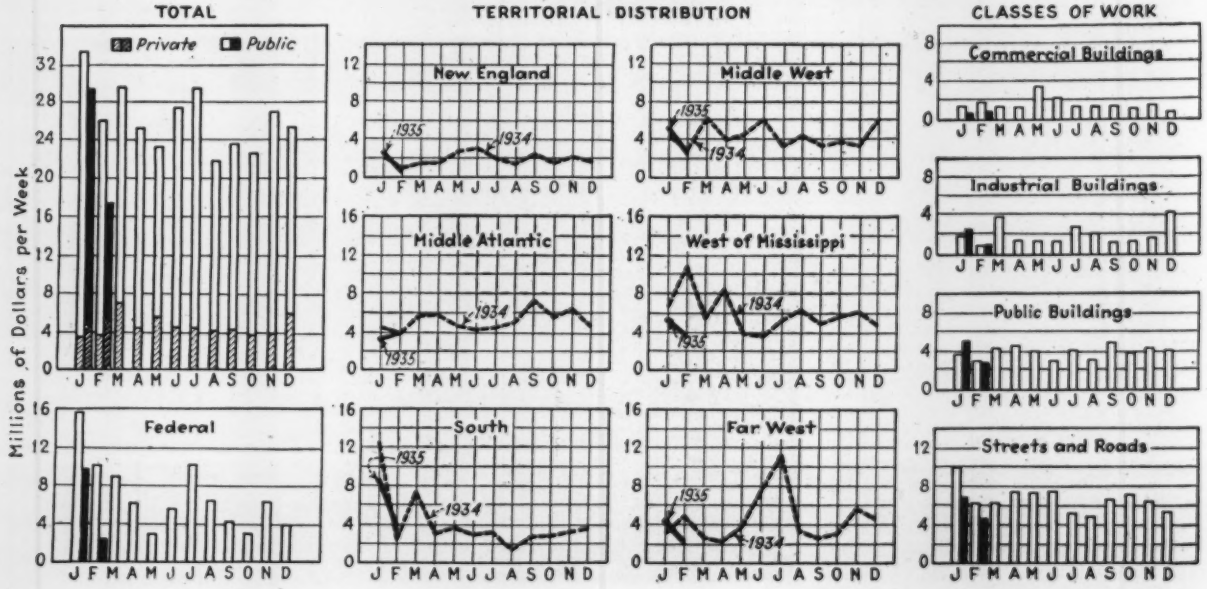
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN FEBRUARY, 1935

Four Weeks—Thousands of Dollars—(000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Feb. 1935	United States Two Months 1935	United States Two Months 1934	Canada Feb. 1935
Public Works										
Waterworks	17	122	503	521	689	1,605	3,457	13,123	8,626	26
Sewerage	60	1,797	1,796	110	822	297	4,882	10,364	5,621	78
Bridges, public	153	930	1,450	624	1,287	233	4,677	12,469	16,866	215
Earthwork and waterways	3	123	820	353	576	1,607	3,482	42,874	81,738	331
Streets and roads	732	549	6,275	3,317	5,300	1,922	18,095	52,490	64,696	404
Buildings, public	540	4,282	1,562	1,439	2,246	1,572	11,641	37,253	26,773	2,336
Unclassified, public	78	794	88	29	149	232	1,370	3,816	4,701	30
Total public	1,583	8,597	12,494	6,393	11,069	7,468	47,604	172,389	209,021	3,420
Federal gov't (included in above classifications)	247	2,155	2,329	639	1,386	2,209	8,965	57,701	102,492	.....
Private										
Bridges, private	.....	3,210	25	25	.....	.....	3,260	3,436	1,493	.....
Buildings, industrial	201	818	383	1,675	378	940	4,395	15,809	10,661	428
Buildings, commercial	487	2,857	40	130	110	.....	3,624	7,384	11,526	1,200
Unclassified, private	33	566	2,644	784	3,745	1,434	9,206	17,335	5,141	1
Total private	721	7,451	3,092	2,614	4,233	2,374	20,485	43,964	28,821	1,629
February, 1935 (4 weeks)	**2,304**	**16,048**	**15,586**	**9,007**	**15,302**	**9,842**	**68,089**	.....	.....	**5,049**
January, 1935 (5 weeks)	12,306	17,801	42,636	26,366	27,595	21,560	148,264	.....	.....	4,031
February, 1934 (4 weeks)	4,341	15,609	35,071	11,667	18,249	19,324	104,261	.....	.....	601
Two months, 1935	14,610	33,849	58,222	35,373	42,897	31,402	.....	216,353	.....	9,080
Two months, 1934	12,948	33,791	84,864	29,229	45,304	31,706	.....	.....	237,842	1,757

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.-WEEKLY AVERAGES

□ ---1934 ■ —1935



panies having 98.7 per cent of the steel capacity of the industry increased the first week of February to 52.8 per cent but declined on succeeding weeks to about 50 per cent for the week ending Feb. 24 as reported by the American Iron and Steel Institute. This compares with 45 per cent for the same period last year.

Fabricated structural steel showed a seasonal decline during January, according to the American Institute of Steel Construction. Reports from shops representing 68 per cent of the industry indicate that bookings were approximately 38 per cent less than the yearly average for 1934 and 45 per cent less than for January a year ago. Shipments were approximately 20 per cent lower than the average for the past 6 months, but showed a 15 per cent increase over the average for the first 6 months of 1934 and were 52 per cent greater than for January, 1934.

Lumber—Lumber shipments for the weeks ending Feb. 2 and Feb. 9 were heavier than any week of the fourth quarter of 1934, according to reports from 1057 mills to the National Lumber Mfrs. Assn. The lumber movement from the mills for the week ended Feb. 16 was somewhat lower. Shipments reported by 1,192 mills for the high week totalled 202,222,000 ft.

Prices

February prices as a whole were steady. Adjustments continued in lumber prices in several centers with further changes expected. Delivered prices for cement in Detroit returned to the price which preceded the 10c. drop last month.

Building Permits

Building permits reported monthly by Dun & Bradstreet totalled $26,811,499 in January, the highest month since January, 1932, and an increase of 28.7 per cent and 51.1 per cent, respectively, over the January figures for 1934 and 1933. Most of the permits were for small amounts, reflecting interest in repairing and modernizing.

Labor

The employment index for the production of six major construction materials is reported by the Federal Employment Stabilization Office to be 38.0 for January compared with 39.8 in December and 51.6 in January of last year. The index base is 1923-1925 = 100.

Employment on public and private building construction projects not aided by Public Works Administration funds declined 11.6 per cent in December compared with November, according to the Bureau of Labor Statistics, U. S. Department of Labor, and based on reports from 10,453 firms. Payrolls were down 13.1 per cent and man-hours worked down 14.1 per cent. Employment varied in different parts of the country; for example, at Birmingham the decrease in December from the November total was only 6.2 per cent, in Los Angeles it was 12.5 per cent, in San Francisco and Oakland an increase of 4.8 per cent was registered with an increase of 3.7 per cent for other localities in California. Denver reported an increase of 17.8 per cent; Bridgeport, Conn., a decrease of 22.7 per cent; Hartford, 10.2 per cent; New Haven, 10.3 per cent, or an average of 13.2 per cent for the state. Florida employment was up 4.8 per cent in Miami but down 9.7 per cent in Jacksonville. Illinois showed a heavy loss, 42.4 per cent in Chicago and 26.4 per cent in other localities; Indiana, an average drop of 27.3 per cent for the state; Massachusetts, 10.2 per cent; Michigan, 4.5 per cent; Minnesota, 11.9 per cent; Missouri, 13.3 per cent; New York, 11.2 per cent; Ohio, 18.1 per cent; Oklahoma, an increase of 10.8 per cent, with a 47.2 per cent increase in Oklahoma City. Pennsylvania employment dropped 14.6 per cent; Tennessee, 14.9 per cent; Texas, increased 5.4 per cent, with increases of 26.8 per cent in Dallas and 11.5 per cent in El Paso; Virginia increased 3 per cent, while Washington state dropped 9.1 per cent and Wisconsin, 1.4 per cent.

Employment on Public Works Administration financed projects declined to 382,594 employees on December 15 compared with 470,000 workers in November and 510,000 workers in October. Of these 382,594, 254,665 were on federal projects and 109,515 on non-federal work financed by PWA funds.

Contrasted with the drop of 87,400 workers on PWA projects is an increase of 170,000 workers on the emergency work program of FERA. More than 1,500,000 workers were on FERA payrolls during the week of December 27. Due to the rotation system of providing work, more than 2,000,000 people were on FERA payrolls in December.

Labor controversies during February were concerned chiefly with the status of union labor rather than wage rates. At Baltimore, on February 26, 60 carpenters employed on the Bath street viaduct walked out on union orders in sympathy with union ironworkers who had been on strike for two weeks. A group of non-union ironworkers continued work. The Building Trades Council is reported to have called its ironworkers, carpenters, plumbers, reinforced-rod workers, cement finishers, engineers, laborers and truck drivers from work on the viaduct. The United Building Trades Federation of America, Inc., not affiliated with the American Federation of Labor, is reported to have offered to supply replacements if the A. F. of L. men did not return.

At Rochester, N. Y., mason contractors maintained a firm stand in their refusal to grant a closed shop to the Laborers' Union.

At Newark, 14 union ironworkers were called out on strike at the Newark Post Office on the 14th in protest against using government employees in unloading and erecting shelving, desks and lockers in the building which the union claimed should be done by their men. They were ordered back the following day under a ruling that while some minor unfair conditions existed on the job, no contractors were involved and the situation had been brought about by the Federal government. It was further pointed out that any possible grievance would rest with the sheet metal workers, who had registered no protest.

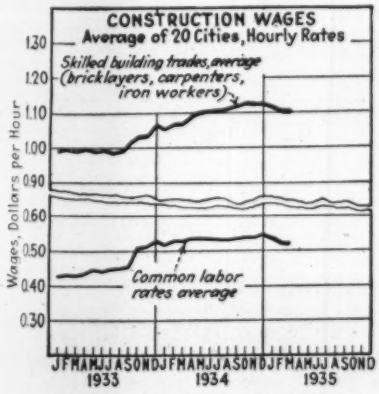
The new senior high school at Bayonne, N. J., took the limelight when the Public Works Administration ordered payment of $2 a day more than the current union scales to some of the skilled trades who will work on the new building. The rates are based on the union scale in effect on April 30, 1933. The following rates were set: Bricklayers, $1.65 per hr.; plumbers and steamfitters, $1.75; electricians, $1.81½; hoisting engineers, $2. The present union scale is bricklayers, $1.50; plumbers and steamfitters, $1.50; electricians, $1.50, and by a code arrangement, hoisting engineers, $1.75, although the union rate is still $2.

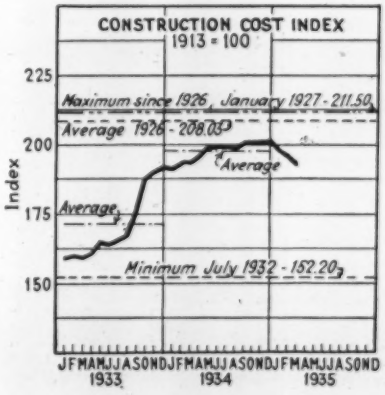
EN-R Cost and Volume Index

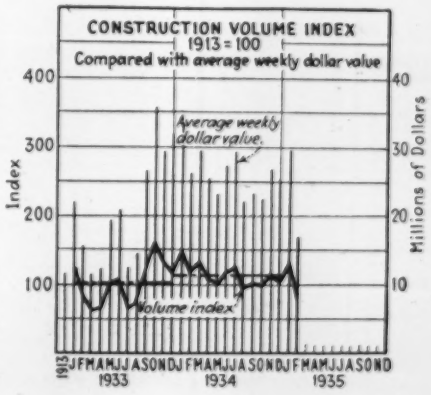
THE *Engineering News-Record* construction cost index for March is 193.46 with the decline due to a drop in lumber.

The volume index for February is 76 compared with 116 a year ago. This decrease is due principally to lighter federal awards.

	INDEX NUMBER				
E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
Mar., 1935	**193.46**	**93.00**	**Feb., 1935**	**76**	**33**
Feb., 1935	196.02	95.52	Jan., 1935	130	57
Mar., 1934	194.06	93.20	Feb., 1934	116	51
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONSTRUCTION WAGES
Average of 20 Cities, Hourly Rates
Skilled building trades, average (bricklayers, carpenters, iron workers)
Common labor rates average
Wages, Dollars per Hour
1.30
1.20
1.10
1.00
0.90
0.60
0.50
0.40
0.30
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935


CONSTRUCTION COST INDEX
1913 = 100
Maximum since 1926, January 1927 - 211.50
Average 1926 - 208.03
Average
Average
Minimum July 1932 - 152.20
Index
225
200
175
150
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Ready Mixed 1:2:4, 50c. yd. or more, delivered
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8.25
Baltimore	2.66	2.41	2.21	1.80‡	2.00‡	1.25‡	1.80‡	1.80‡	2.25	2.25	7.35
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.45
Boston	2.72	2.47	2.27	1.60	1.60	1.15	1.60	1.60	.....	.....	7.00
Chicago	2.85‡	2.60‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	.....	.....	.....
Cincinnati	2.57	2.32	2.12	1.20	1.20	1.10	1.80	1.80	.....	.....	6.70
Cleveland	2.45	2.20	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.10	1.10	.70	2.10	2.25	.....	.....	7.00
Denver	3.10	2.85	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.40	1.30	1.20	1.10	1.10	1.30‡	1.30‡	6.00
Kansas City	2.50	2.25	2.05	.....	1.85	1.15	1.85	1.40-1.55	.....	.....	7.65
Los Angeles	2.90	2.62	.....	1.60	1.60	1.20	1.60	1.60	.....	.....	6.70
Minneapolis	2.85	.....	2.40	1.00[p]	1.00[p]	.25[p]	1.00[p]	1.00[p]	.....	.....	6.90
Montreal	.....	1.70	.....	.85	.90	.40	.85[p]	.95½[p]	.....	.....	6.00
New Orleans	2.37	2.15	2.00	1.85	1.85	1.50	.....	.....	.....	.....	7.65
New York	2.65‡	2.40‡	.....	1.30†[k]	1.30†[k]	.85†[k]	1.75†[k]	1.85†[k]	.....	.....	7.60
Philadelphia	2.60	2.35	.....	1.80‡	1.90‡	1.50‡	1.75‡	2.00‡	1.75‡	1.75‡	7.75
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.42	2.17	.....	1.25‡	1.25‡	1.25‡	.75[p]	.75[p]	.75§	.75§	6.50
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	2.95	2.70	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	7.56

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. [k]Barge lots alongside dock. [p]f.o.b. plant. [5] tons or more.

CURRENT MAXIMUM NET PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich.	$1.50	$1.45	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala.	$1.75	$1.70
Buffington, Ind.	1.60	1.55	Iola, Kans.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Crestmore, Calif.	1.72	.....	La Salle, Ill.	1.60	1.55	Saginaw, Mich.	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.60	1.55	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.60	1.55	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Norfolk, Va.	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans.	1.70	1.65	Northampton, Pa.	1.65	1.60	Wyandotte, Mich.	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over, 3x12x12 in.)	(4x12x12 in.)	(8x12x12 in.)	STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over, 8x12x12 in.)	(10x12x12 in.)	(12x12x12 in.)	BRICK (Per M, in quantity, Common backing)	(Straight hard)	LIME (Per ton, Hydrated finishing)	(in paper, Common hydrated)	(carload lot, Pulverized or lump)
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25	$24.00	$17.00	$15.90
Baltimore	74.50	80.00	150.00	180.00	209.00	260.00	13.00	17.00	16.75	11.25	19.00
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	3.00§	1.75§	2.25§[r]
Boston	85.30	91.15	171.00	193.50	239.60	273.40	14.50	17.00	19.00	14.00	3.36[y]*
Chicago	66.00	70.40	132.00	.....	.....	.....	10.20	11.20	18.00	13.40	14.00
Cincinnati	69.95	74.60	139.90	139.90	174.65	199.20	17.50	17.50	15.97	12.48	.....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	16.50	16.50	17.20k	14.40k	2.65k[p]
Dallas	71.00	76.00	149.00	196.00	240.80	297.00	13.50	22.00	21.20	14.50	1.70 [p]
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00–15.50	21.00–30.00	25.00	17.00	20.00
Detroit	63.60	67.80	127.10	230.00	270.00	330.00	11.50	12.50	14.30	12.05	21.56
Kansas City	72.50	75.50	92.00*	140.50	177.75	207.25	15.00	24.00	15.00	11.25	14.00*
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	19.00	19.00
Montreal	79.10s	90.40	169.50s	.....	212.40	.....	17.00	22.50	23.00	13.00	.....
New Orleans	61.60	65.70	123.20	158.90	196.70	.....	14.00	.....	16.75	13.05	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	12.00	.....	20.80	16.00	20.80
Philadelphia	80.50	85.90	161.00	182.50	235.00	272.00	15.00	18.00	16.35	11.25	10.75
Pittsburgh	72.65c	77.45c	145.00c	165.00c	217.00c	250.00c	17.50	22.06	16.70	15.10	2.75[p]*
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.80[c]
San Francisco	64.00	94.50	225.00	.....	.....	.....	15.00	18.00	22.50	21.50	2.05[p]
Seattle	86.00	94.50	210.00	198.00	.....	.....	15.00[d]	18.50	30.00	26.00	3.00[p]

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. [p]Per bbl. 180 lbs. [c]per bbl. 280-lb. kLCL. [d]less $1 cash 15 days. [r]lump. [s]Smooth. x Selected common.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS: Granite (per M, lots of 50,000, 4x4x8 in.,	Brick (per M, 3x8½x4 in., carload lots	Wood (per sq. yd., 3½ in., 16-lb. treat,	PAVING ASPHALT (Per ton, less than 80 penetration, Tank car	Drums	ASPHALT BINDERS—FLUXES (Per gal., 80-300 penetration, Tank car	Drums	CUTBACK ASPHALT (Per ton, Tank car	Drums	ROAD OILS (Per gal., Tank car	ASPHALT EMULSION (Per gal., Tank car	Drum
Atlanta	$ 80.00	$35.00	$2.25	$17.40[z]	$22.47[z]	$0.0694[z]	$0.961[z]	$19.65[z]	$25.57[z]	$0.0694[z]	$0.105	$0.105
Baltimore	110.00	44.00	2.25	17.00	22.00	.07	.095	.085†	.12†	.....	.....	.....
Birmingham	110.00[f]	24.00	.....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	85.00	30.00	2.75	16.00	21.00	.075	.10	.09†	.12†	.075	.09	.125
Chicago	138.00	42.00	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	115.00	37.00	.....	18.00	22.00	.09	.....	18.50	.....	.07	.08	.....
Cleveland	100.00‡	32.75	2.95	20.00	24.50	.075	.09	.075†	.049†	.06	.085	.10
Dallas	.....	30.00	.....	16.10	21.10	.0525	.10	15.65	23.15	.055	.1076	.1438
Detroit	.....	37.00	.....	19.67[x]	24.87[x]	.....	.....	17.00	22.50	.....	.....	.....
Kansas City	.....	45.00	.....	18.30	23.30	17.30#	22.30#	.075†	.105†	.055	.11	.15
Los Angeles	.....	50.00	.....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.10	24.60	.098	.098	21.75	34.55	.048	.....	.....
Montreal	.....	110.00	.....	14.00	19.66	.07	.093	19.00	26.00	.07	.125	.155
New Orleans	100.00	32.00	.....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	125.00§	50.00	2.64	17.00	22.00	.07	.095	.085†	.12†	.....	.085	.12
Philadelphia	120.00	45.00	2.25	15.00	20.00	.06	.....	.07†	.10†	.06	.....	.....
Pittsburgh	115.00	40.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	117.50	35.00	2.00	19.50	24.50	.0775	.1075	.0875†	.118†	.04	.09	.125
San Francisco	.....	50.00	.....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	55.00	.....	17.00	23.00	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudez, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½ in. §4x5x9-in. Av. [x]Mexican. [z]local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. [f]Per ton.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS	RIVETS	WIRE NAILS	SHEET PILING	STEEL RAILS (Per Gross Ton)			TRACK SUPPLIES			
		¾-in. billet, base price	½-in. structural	Base	Base	Standard	Light	Re-rolled	Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.95	$2.00	....	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.80	2.65	2.90	$2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—BASE MILL PRICES, PER 100 LB., CARLOAD LOTS

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb ¾ in., base price		EXPANDED METAL LATH —Per 100 sq.yd., carload lots—		WELDED FABRIC REINFORCING —Per 100 s.f., carload lots—		6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb., base price
		New billet	Rail steel	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires		
Atlanta	$3.34	$2.32	$2.17	$21.00	$24.00	$1.53	$1.16	$0.1449	$2.65
Baltimore	2.95	2.75	2.60	22.00	25.00	1.41	1.08	.1332	2.75
Boston	3.52	3.03	2.2125	20.50	24.50	1.46	1.12	.1449	2.30
Chicago	3.20	2.10	1.95	22.00	26.00	1.40	1.08	.1323	2.25
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	....
Cleveland	3.16	2.63	2.45	20.00	23.00	1.37	1.06	.1287	....
Dallas	4.00	2.80	2.65	24.50	26.50	1.63	1.23	.1548	2.985
Denver	3.91	3.76	....	25.00	27.50	1.68	1.26	.1548	....
Detroit	3.40	2.885	2.885	20.20†	23.60†	1.41	1.08	.1323	2.25
Kansas City	3.53	2.68	2.53	19.00	22.00	1.50	1.14	.1422	2.67
Los Angeles	3.10	2.95	....	23.00	27.50	1.68	1.26	.1584	2.50
Minneapolis	3.45	2.82	2.67	22.00	26.00	1.51	1.15	.1431	2.55§
Montreal	2.75	3.00	2.80	.....	.....	2.30	1.71	.238	2.65
New Orleans	....	....	....	19.15	23.00	1.54	1.17	.1458	....
New York	3.37	2.82	2.67	20.00	22.00	1.43	1.10	.1350	2.48
Philadelphia	2.005	2.34	2.19	20.00	23.50	1.42	1.09	.1332	2.44
Pittsburgh	1.80‡	2.05‡	1.90‡	20.75‡	23.00‡	1.34	1.04	.1260	2.15
St. Louis	3.44	2.94	2.79	22.00	24.00	1.42	1.09	.1341	2.25
San Francisco	3.55	2.475	2.35	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.50	2.50	....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots# in oil	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots, f.o.b. factory				
			Graphite*	Aluminum†	Ferric Oxide‡	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$10.50	$1.60	$3.10	.....	$2.01	$1.97	$2.90	$ .36	$25.40
Baltimore	7.00	10.00	1.40	2.25	$1.90	2.32	2.55	2.55	.48	24.60
Birmingham	7.25	10.50	2.35	2.35	1.85	1.95	1.79	....	36	23.00
Boston	7.00	10.00	1.75	2.60	.04½x	2.10	3.20	3.20	.45	20.00
Chicago	7.00	10.00	1.85	2.45	1.30	1.60	1.59▪	1.59▪	.24	20.00
Cincinnati	7.00	10.00	1.40	3.00	1.55	2.40	2.39▪	2.39▪	36	21.00
Cleveland	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79▪	.24	22.00
Dallas	7.25	11.00	1.80	2.24	.....	2.28	3.40	3.40	.28	34.00
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	60	30.00
Detroit	7.00	10.00	1.45	2.20	1.30	2.55	2.80	2.80	37	30.00
Kansas City	7.00	10.12½	1.25	2.25	.95	2.05	3.10-3.20	3.10-3.20	23	26.50
Los Angeles	7.25	9.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.12½	.....	.....	.....	1.60	1.79▪	1.79▪	.29	25.10
Montreal	....	9.40	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York	7.00	10.00	1.65	2.25	1.50	1.60	1.79▪	1.79▪	.232	22.00
Philadelphia	7.00	10.00	1.50	2.05	1.50	1.68	1.85▪	1.85▪	.34	22.00
Pittsburgh	7.00	10.00	1.05	1.95	.80	1.75	1.65▪	1.65	.38	22.00
St. Louis	7.00	10.00	1.85	2.45	1.30	1.87½	3.22	3.22	.28	20.00
San Francisco	7.25	9.75	1.80	2.75	1.10-2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	9.75	1.80	2.85	2.25	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. ▪Per roll 65 lb. xPer lb. ▸500-lb. drums.
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928

	Single or Double Thickness A quality	B quality
Atlanta	85%	85%
Baltimore	88-10%	90-10%
Birmingham	88%	90%
Boston	88-10-5%	90-10-5%
Chicago	90%	92%
Cincinnati	89-10%	91-10%
Cleveland	89-10%	91-10%
Dallas	87%	89%
Denver	84%	86%
Detroit	87-10%	89-10%
Kansas City	88-10%	90-10%
Los Angeles	90%*	90-40%
Minneapolis	85%	87%
Montreal	....	....
New Orleans	88%	90%
New York	88%	90%
Philadelphia	88-30%	90-30%
Pittsburgh	88%	▪88%
St. Louis	90%	92%
San Francisco	90%	90-‡30%
Seattle	90-10%	90-20%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin 40%	60%
Atlanta	$0.155	$0.17
Baltimore	.16	.175
Birmingham	.11	.125
Boston	.165	.1775
Chicago	....	....
Cincinnati	.27	.29
Cleveland	.19	.205
Dallas	.17	.185
Denver	.155	.17
Detroit	.237	255
Kansas City	.16	.175
Los Angeles	.1725†	1925†
Minneapolis	.17	.185
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.225	.24
Philadelphia	....	....
Pittsburgh	105	.12
St. Louis	.135	15
San Francisco	.1575	1775
Seattle	1425	1575

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90@$2.15
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb	1.20
Sulphate of aluminum, commercial, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb.	3.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12in. at butt	6in.	30 to 50 ft.	$0.11	$0.155	$0.12	$0.15
12in.—2ft. from butt	6in.	50 to 59 ft.	.15	.20	.14	.19
12in.—2ft. from butt	6in.	60 to 69 ft.	.16	.215	.15	.20½
14in.—2ft. from butt	6in.	50 to 69 ft.	.185	.225	.19½	.23½
14in.—2ft. from butt	6in.	70 to 79 ft.	.2025	.225	.23½	.29½
14in.—2ft. from butt	5in.	80 to 85 ft.	.265	.375	.....	.....
14in.—2ft. from butt	5in.	85 to 89 ft.	.305	.442	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.15	$1.60
	Pine, untreated	1.15	1.60
	Pine, creosoted	1.60	2.25
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	no market	
	Southern pine, untreated *6x8x8'6'	.45*	.60
	Southern pine, creosoted	1.00*	1.20
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1 78
Los Angeles	Fir, untreated	.50	72
	Fir, creosoted	1.67	2 40
Philadelphia	Red oak, untreated	1.15	1.35
	Red oak, creosoted	1.40	1.65
	White oak, untreated	1.10	1.45
St. Louis	Red oak, untreated	1.08	1.40
	Red oak, creosoted	1.45	1.95
	Sap Pine or cypress, untreated	85	1.25
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. and over*	Per foot, delivered, standard (‡ f.o.b.) 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-24 12 in.	24 in.	Full standard weight. # 1 to 3 in., Black	Butt Weld Galv.	3½ to 6 in., Black	Lap Weld Galv.
Atlanta	$42.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	44%	37%	42%	34%
Baltimore	45.50	.24	.46	2.05	5.65	105.00	165.00	.75	2.00				
Birmingham	38.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	45.50	.231	.4455	2.025	5.945	60.10	101.00	.54	1.90				
Chicago	46.50	.28	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	57%
Cincinnati	45.00	.231	.4455	1.935	5.8425	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.245%
Cleveland	46.50	.21	.405	1.71	5.2275	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	50.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	53%	65–5%	56–5%
Denver	58.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	56%	45%	43%*	57%*
Detroit	46.50	.238	.456	1.935	5.74	58.10	97.20	.35	1.55	48.6%	38.2%	47.3%	37.6%
Kansas City	48.00	.32	.57	2.27	4.90	120.00	240.00	.35	1.20				
Los Angeles	46.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	48.50	.283	.51	2.04	5.13	.....	.....	.50	1.33	.....	.....	.....	.....
Montreal	.....	.80	1.50	6.00	.....	45.00	90.00	.45	.....	.....	.....	.....	.....
New Orleans	44.00	.282	.465	1.65		60.00	.....	.51	1.69				
New York	45.00	.322	.621	2.73	7.60	.....	.....	.55	2.00	51.88%*	40.86%*	53.10%*	42.08%*
Philadelphia	42.00	.315	.6075	2.70	.....	150.00	230.00	.....	.....	52.37%*	41.35%*	53.39%*	42.57%*
Pittsburgh	48.00	.224‡	.432‡	1.845‡	5.535‡	69.00	108.00	.75	1.75	64%	55%	65%	56%
St. Louis	45.00	.27	.486	1.944	3.96	85.00	172.00	.80	2.28	51.51%	40.49%	52.74%	41.71%
San Francisco	46.00	.265	.477	1.908	5.22	105.00	175.00	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	47.50	.34†	.60†	2.40†	6.30†	85.00	200.00	1.50	1.60	60.3%	51.3%	65.3%	52.3%

*b. & s. class B and heavier, C/L lots. Burlington, N. J. (base) $42.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional.

‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in. 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

▲2½ to 3 in. *Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.								LONG LEAF Y. P. Merchantable grade up to 20 ft.	
		1x6,S	1x8,S	2x4,S	2x6,S	2x8,S	2x10,S	3x12,R	6x12,R	12x12,R	2x12,R	12x12,R
Atlanta	Southern Pine	$16.00	$17.00	$19.00	$16.50	$18.00	$18.50	$30.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	23.00	24.00	29.50	28.50	29.00	30.50	37.50	.....	.....	54.00	55.00
	Douglas Fir	29.00	29.00	31.00	29.00	30.00	30.50	30.00	$30.00	$30.00	.....	.....
Birmingham	Long Leaf	18.25	19.25	21.25	19.25	20.25	20.25	42.00	.....	.....	32.00	39.80
	Southern Pine	18.25	19.25	20.00	18.00	19.00	19.00	29.00	29.00	28.00	.....	.....
Boston	Southern Pine	32.00	33.00	40.00†	42.00†	55.00‡	64.00‡	76.00‡	.....	.....	76.00	76.00
	Douglas Fir	31.00	32.00	40.00	40.00	40.00	42.00	43.00	45.00	45.00	.....	.....
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.80	45.00	.....	.....	54.00	58.00
	Douglas Fir	28.50	29.50	31.50	30.50	30.50	28.50	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	26.00	27.00	27.50	25.50	26.50	27.50	43.50	.....	.....	43.50	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	46.25	46.25	46.25	.....	.....
Cleveland	Southern Pine	27.00	28.00	31.00	28.00	30.00	30.50	45.00	45.00	.....	46.00	57.00§
Dallas	Southern Pine	26.45	27.10	29.02	26.27	27.92	28.72	42.44	.....	.....	47.55	55.55
	Douglas Fir	29.45	30.53	33.28	30.53	38.64	32.95	44.85	44.85	44.85	.....	.....
Denver	Douglas Fir	34.00	36.50*	39.00*	38.00*	38.00*	41.00*	49.00*	53.00*	58.50	.....	.....
Detroit	Southern Pine	26.00	27.50	30.00	27.00	30.00	32.00	37.00	.....	.....	32.00	43.75
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.25	44.25	44.25	.....	.....
Kansas City	Southern Pine	22.50	23.50	23.50	22.50	23.50	24.50	35.00	.....	.....	47.50	57.50
	Douglas Fir	22.75	23.75	26.00	25.00	25.00	26.50	35.00	35.00	35.00	.....	.....
Los Angeles	Douglas Fir	24.00„	25.50„	26.00„	26.00„	26.00„	26.00„	30.00„	38.00„	34.00„	.....	.....
Minneapolis	Western Pine	44.00*	41.25*	34.00*	31.50*	33.00*	31.50*	50.75*▲	.....	.....	.....	.....
	Douglas Fir	33.25*	34.50*	36.00*	33.50*	35.00*	37.00*	47.00*	50.75*	50.75*	.....	.....
Montreal	Spruce	30.00	31.00	27.00	29.00	30.00	35.00	38.00	.....	.....	.....	.....
	Douglas Fir	42.50	42.50	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	27.90	28.95	33.70	28.90	31.35	32.40	43.95	.....	.....	45.65	52.45
	Douglas Fir	28.95	31.50	33.90	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	32.00*	33.00*	32.00*	33.00*	34.00*	35.00*	45.00*	.....	.....	70.00*	70.00*
	Douglas Fir	.....	.....	38.00*	37.00*	38.00*	39.00*	37.00*	39.00*	39.00*	.....	.....
Philadelphia	Southern Pine	24.50	25.50	27.00	25.50	26.50	27.00	31.00	.....	.....	61.00	59.00
	Douglas Fir	.....	.....	31.00	31.00	31.00	31.00	32.50	32.50	33.50	.....	.....
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50	.....	.....	57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25	.....	.....
St. Louis	Southern Pine	27.00*	28.50*	29.00*	26.00*	27.50*	27.50*	55.00*	.....	.....	59.00*	67.00*
	Douglas Fir	.....	.....	.....	.....	.....	.....	55.00*	55.00*	55.00*	.....	.....
San Francisco	Douglas Fir	15.00t	16.00t	17.00t	14.50t	15.50t	16.50t	21.00t	21.00t	21.00t	.....	.....
Seattle	Douglas Fir	13.00	14.00	14.00	11.50	12.50	12.00	18.50	18.00	18.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. ▲Northern Pine. t Douglas fir. ~Native. t At ship's tackle. „Yard prices. #S4S. ≠Rgh.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor — Building	Common Labor — Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.40
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.40/.70	.40/.70
Cincinnati	1.27½	1.02½	1.20	1.07½	1.27½	.45	.40
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.25	1.25	.72	.72
Dallas	1.00	1.00	1.00	1.00	1.00	.40	.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.50	.50/.70
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.125	1.10	1.25	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.45/1.65	1.50/1.56½	1.50	.82½	.50/.82½
Philadelphia	.75/1.20	.60/1.20	1.00/1.20	.75/1.20	.60/1.20	.30/.50	.30/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	.90/1.00	.90/1.00	1.00/1.30	1.00/1.25	.90/1.50	.45/.65	.50/.65
Montreal	0.70	.60	.75	.55	.67	.35	.25

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.1093. Common Avg. $0.5243 *6-hr. Day. † PWA.